# REPORT DOCUMENTATION PAGE

**1a. REPORT SECURITY CLASSIFICATION:** UNCLASSIFIED

**1b. RESTRICTIVE MARKINGS:**

**2a. SECURITY CLASSIFICATION AUTHORITY:**

**2b. DECLASSIFICATION/DOWNGRADING SCHEDULE:** N/A

**3. DISTRIBUTION/AVAILABILITY OF REPORT:** Approved for public release, distribution is unlimited.

**4. PERFORMING ORGANIZATION REPORT NUMBER(S):** D180-28861-1

**5. MONITORING ORGANIZATION REPORT NUMBER(S):** AFWAL-TR-85-2060, Vol. II, Part 1

**6a. NAME OF PERFORMING ORGANIZATION:** Boeing Military Airplane Co.

**6b. OFFICE SYMBOL** *(If applicable)*:

**7a. NAME OF MONITORING ORGANIZATION:** Aero Propulsion Laboratory, Fire Protection Branch (AFWAL/POSH)

**6c. ADDRESS** *(City, State and ZIP Code)*: P.O. Box 3707, Seattle, WA 98124-2207

**7b. ADDRESS** *(City, State and ZIP Code)*: Air Force Wright Aeronautical Laboratories, Wright-Patterson AFB, OH 45433-6563

**8a. NAME OF FUNDING/SPONSORING ORGANIZATION:** Aero Propulsion Laboratory

**8b. OFFICE SYMBOL** *(If applicable)*: AFWAL/POSH

**9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER:** F33615-78-C-2063

**8c. ADDRESS** *(City, State and ZIP Code)*: Air Force Wright Aeronautical Labs, Wright-Patterson AFB, OH 45433-6563

**10. SOURCE OF FUNDING NOS.**

| PROGRAM ELEMENT NO. | PROJECT NO. | TASK NO. | WORK UNIT NO. |
|---|---|---|---|
| 62203F | 3048 | 07 | 86 |

**11. TITLE** *(Include Security Classification)*: See attached page

**12. PERSONAL AUTHOR(S):** A. M. Johnson

**13a. TYPE OF REPORT:** FINAL

**13b. TIME COVERED:** FROM 2/81 TO 10/84

**14. DATE OF REPORT** *(Yr., Mo., Day)*: January 1986

**15. PAGE COUNT:** 292

**16. SUPPLEMENTARY NOTATION:** The computer software contained herein are theoretical and/or references that in no way reflect Air Force - owned or developed computer software.

**17. COSATI CODES**

| FIELD | GROUP | SUB. GR. |
|---|---|---|
| 21 | 02 | |
| | | |

**18. SUBJECT TERMS** *(Continue on reverse if necessary and identify by block number)*: Combat damage, Engine compartment extinguishant systems, Fire extinguishant agent evaluation, Halon 1202, Halon 1301, Hot surface ignition, Ultraviolet fire detection system, Ventilation airflow

**19. ABSTRACT** *(Continue on reverse if necessary and identify by block number)*

Fire tests and extinguishant concentration tests were conducted using a simulated portion of the F-16 aircraft engine compartment in the Aircraft Engine Nacelle (AEN) fire test simulator at WPAFB. combat damage simulation included outer compartment wall penetration allowing either inflow or outflow of ventilation airflow through an external wound and fan perforation or engine bleed air line damage. "Standard" fire and agent concentration test techniques were developed.

Existing specifications were found to be adequate in terms of quantity of extinguishing agent. Results also indicated that more rapid agent release resulted in more effective use of the agent. Halon 1301 performed significantly better than Halon 1202, contrary to what the available literature indicated. Fires with combat damage inflow simulation added were the most difficult to extinguish because hot surface ignition sources were created soon after the test fire was ignited. For these, the quantity of agent specified would have been adequate only if the agent reached the fire within a few seconds after ignition.

**20. DISTRIBUTION/AVAILABILITY OF ABSTRACT:** UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☒ DTIC USERS ☐

**21. ABSTRACT SECURITY CLASSIFICATION:** UNCLASSIFIED

**22a. NAME OF RESPONSIBLE INDIVIDUAL:** John C. Sparks

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**22c. OFFICE SYMBOL:** AFWAL/POSH

19. ABSTRACT (continued)

An automatic detection/dump system might be required to provide adequate protection in these combat damage cases.

11. TITLE

VULNERABILITY METHODOLOGY AND PROTECTIVE MEASURES FOR AIRCRAFT FIRE AND EXPLOSION HAZARDS

Volume II - Aircraft Nacelle Fire Test Program

Part 1 - Fire Detection, Fire Extinguishants and Hot Surface Ignition Studies

This report is one of the set of aircraft fire protection reports contained in AFWAL-TR-85-2060 as listed below:

Volume I Executive Summary

Volume II Aircraft Engine Nacelle Fire Test Program

Part 1 Fire Detection, Fire Extinguishment and Hot Surface Ignition Studies

Part 2 Small Scale Testing of Dry Chemical Fire Extinguishants

Volume III On-Board Inert Gas Generator System (OBIGGS) Studies

Part 1 OBIGGS Ground Performance Tests

Part 2 Fuel Scrubbing and Oxygen Evolution Tests

Part 3 Aircraft OBIGGS Designs

AFWAL-TR-85-2060, Vol. 2, Pt. 1.

Vol~~ume II~~ 2 : Aircraft Engine Nacelle Fire Test Program.
Part 1 : Fire Detection, Fire Extinguishment and Surface Ignition Studies.

# VULNERABILITY METHODOLOGY AND PROTECTIVE MEASURES FOR AIRCRAFT FIRE AND EXPLOSION HAZARDS.

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January 1986

Final Report for Period February 1981 - October 1984



AERO PROPULSION LABORATORY
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WRIGHT-PATTERSON AIR FORCE BASE, OH 45433-6563

Volume III <u>On-Board Inert Gas Generator System (OBIGGS) Studies</u>

Part 1 OBIGGS Ground Performance Tests

Part 2 Fuel Scrubbing and Oxygen Evolution Tests

Part 3 Aircraft OBIGGS Designs

Boeing acknowledges the contributions of the design and technical personnel of Technical/Scientific Services, Inc. (TSSI) for their support to this program and to R. G. Clodfelter of the Air Force for his technical guidance during the research studies and for his efforts to develop these national facilities for generalized investigations of techniques to improve aircraft fire safety.

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## 1.0 INTRODUCTION

Fires are a constant threat in an aircraft engine compartment because it contains a variety of combustible fluids, an abundance of air and various possible ignition sources, all in close proximity. In addition to the fuel supply to the engine, hydraulic fluids and lubricating oils are routed through regions where potential ignition sources, such as hot surfaces and electrical arcs, may be present.

The variables which affect the hazard of accidental fire in an engine compartment are complex:

- o The fuel type, its temperature and pressure, and its method of introduction (spray, drip, pool).
- o The direction, velocity, temperature and density of the ventilation airflow.
- o The temperature, shape, size, material and surface conditions of the hot surfaces.
- o The nature and location of an electrical arc.

Protecting the engine compartment has received much attention over the years. The interested reader will find a detailed review of the engine fire protection studies in a report by Altman, Ling, Mayer and Myronuk (Ref. 1). Currently, Halons are the extinguishants of choice for most aircraft engine compartments. However, factors such as increasing engine compartment temperatures found in advanced aircraft and engines and combat threats require continuing research to ensure that both the agent used and the manner in which it is released are optimized for the flight environment.

Analytical modeling of engine compartment fires and their interactions with extinguishants is extremely difficult. The number of possible chemical reactions is very large and the combustion process is influenced by the combustibles involved, the temperature field, local air flow velocities, and engine compartment materials. Furthermore, the reactions involved in the extinguishing process are not well understood. Therefore, experimental results and correlations based on empirical factors have, and will continue to be, the basis for establishing engine fire protection requirements.

With combat damage, the problem is further complicated by ventilation airflow which can be slightly or substantially changed, depending on the wound. The damage may also introduce additional airflow due to bleed duct damage, and additional ignition sources due to damage to electrical wiring.

The current most common approach to engine compartment fire protection in Air Force multi-engined aircraft is to provide a Halon 1301 extinguishant system designed to comply with specification MIL-E-22285. This specification defines the quantity of Halon 1301 based on compartment size, roughness and ventilation airflow rate, and specifies that an agent concentration of at least 6% (by volume) must persist for 1/2 second following agent discharge.

Halon 1202 is also used in current Air Force aircraft. While no comparable specification exists for this agent, technical report JTCG/AS-74-T-002 provides similar design information for Halon 1202. Although testing in the 1950's indicated that the performance of Halon 1202 was similar to that of Halon 1301 and that it had some advantages, little test data are available to substantiate this.

The design information discussed above does not specifically address the impact of combat damage on Halon requirements. The type and quantity of combustible fluids and the type of ignition sources for a particular engine installation can be identified comparatively easily, but changes in ventilation airflow due to wounds in the outer skin, engine case or bleed air lines are much more difficult to establish. These wounds could change the types of engine compartment fires by either increasing or decreasing the ventilation airflow and diluting or venting the extinguishing agent before the agent reaches the fire. The changes depend on variables such as the wound size and shape, airplane altitude and speed, and the orientation of the wound relative to the airstream. Only limited information was found in published literature or other sources which related battle damage and engine compartment fires.

One source investigated was the Combat Damage Information Center (CDIC) files at WPAFB. Key words were chosen to identify battle damage caused by 7.62, 12.7, 14.5 and 23 mm High Explosive Incendiary (HEI) rounds striking fixed wing, turbine powered aircraft. From the several hundred incidents which resulted from this search, about 40 were identified as potentially valuable information sources. These included incidents involving A-37, B-52, C-130, F-4, F-100 and F-105 airplanes. However, reviewing the individual Document Accession Number (DAN) files proved to be disappointing. Virtually no information surfaced which provided insight into the effect of an HEI strike on engine compartment ventilation or the performance of the extinguishment system. This was probably due to the combat environment which limited the analysis and technical details included in the reports.

Some generalized conclusions were possible:

- o HEI strikes often caused engine compartment fires;

- o the extinguishant systems were only partially successful in providing adequate protection; and

- o engine compartment damage could include engine perforation, external skin perforation and rupture of fuel, lubricant, or hydraulic fluid lines. These could vary from survivable to non-survivable for any of the airplanes or threats studied.

Literature searches were conducted using the Defense Technical Information Center (DTIC) and Boeing Company library systems. Here again, little was found that was directly applicable to the current study. Those that were relevant are cited in subsequent discussions in this report.

The best available basis for establishing the effect of combat damage on ventilation airflow and extinguishant performance was found to be the results of gunfire tests at WPAFB (Ref. 2). These tests provided insight on the type of wounds to expect and the basis for analyzing the effect of aircraft flight conditions and altitudes on ventilation airflow (see Appendix C).

Aircraft engine compartment fire hazards were studied experimentally in this program using the Aircraft Engine Nacelle (AEN) Fire Test Simulator at WPAFB. This facility was constructed in 1980 to simulate an annular segment (about 1/3) between an engine case and an engine compartment outer wall. The facility includes supporting equipment to allow simulation of engine compartment ventilation from sea level to normal cruise altitudes from static to supersonic conditions. Engine compartment ignition hazards, including hot engine bleed air ducts, can be simulated and a variety of fuels can be introduced. Fires can be ignited and extinguished safely using extinguishant systems representative of aircraft systems or a variety of backup systems. Exhaust products from the simulator can be cooled and scrubbed prior to their release into the atmosphere.

Three studies performed in the AEN facility are discussed in this report:

o the effect of removing insulation from an F-16 bleed air duct on engine fire safety;

o the use of nitrogen enriched air (NEA) as an extinguishing agent; and

o the effect of combat damage on Halon extinguishant requirements.

The results of F-16 bleed air duct study are included as Appendix A and have been documented separately (Ref. 3). The results of the NEA study are presented in Appendix B. The combat damage studies are discussed in the main body of the report.

The combat damage studies had the following objectives:

o To verify and/or refine the extinguishant design criteria for compartments without battle damage contained in MIL-E-22285 and technical report JTCG/AS-74-T-002, for bromotrifluoromethane (Halon 1301) and dibromodifluoromethane (Halon 1202) and to establish a baseline for comparison with battle damage effects and advanced designs.

- To examine the actual agent concentration and distribution in the nacelle.

- To determine requirements for a fire extinguishing agent/ distribution system in an aircraft engine nacelle with battle damage using Halon 1301 and Halon 1202.

## 2.0 TEST FACILITY

The Aircraft Engine Nacelle (AEN) Fire Test Simulator is a ground test facility designed to simulate the fire hazards in the annular compartment around an aircraft engine. The AEN is installed in I-Bay of Building 71-B in Area B of Wright-Patterson Air Force Base, Ohio. This facility includes air delivery and conditioning equipment designed to simulate engine compartment ventilation airflow, a test section within which fire testing can safely be conducted and an exhaust system that can cool the combustion products and scrub them sufficiently to allow their release into the atmosphere. In addition, the facility includes a gas fired heating system to provide simulated engine bleed air to the test section. These components are shown in Figure 2-1.

The test section of the AEN (shown in Figure 2-2) consists of a two radian (114 degrees) segment of the annulus between a 15-inch diameter duct, that simulates an engine case, and a 24-inch diameter duct, that simulates the engine compartment outer wall. The test section is approximately 14 feet long and is constructed from 1/4-inch stainless steel. Various access ports and viewing windows are provided for access to test equipment and instrumentation and for observation of the fires in the test section.

Aircraft engine compartment ventilation air velocity, pressure and temperature, fan case temperature, nacelle geometry, and the introduction of aircraft flammable fluids can be simulated. Aircraft fire extinguishing agent release systems can be simulated using various extinguishants, and their effect on fires in the AEN can be observed and recorded.

As shown in Figure 2-1, the AEN ventilation airflow conditioning systems include a blower that provides air at atmospheric pressure to simulate low speed sea level flight conditions, a high pressure compressor and air storage bottle farm that can provide ventilation airflow simulating ram pressure in low altitude supersonic flight conditions and an air driven ejector that can evacuate the test section to simulate high altitude flight conditions. The shorter curved test section wall, that simulates the case of a turbojet or turbofan engine, can be heated with radiant heaters. The test section can be rotated 360 degrees allowing simulation of any 114 degree segment of an aircraft engine compartment.

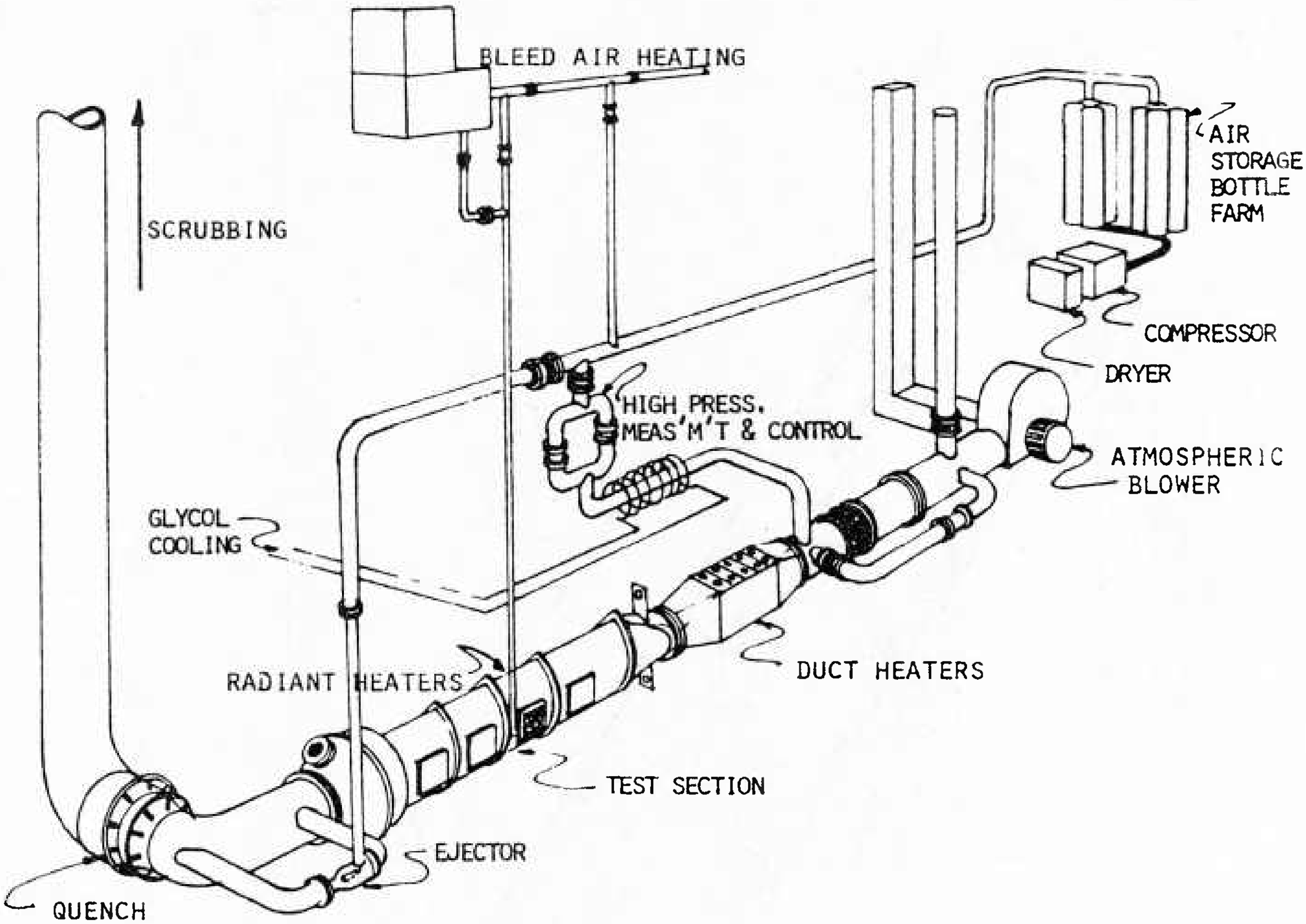



*Figure 2-1. Components of the AEN*

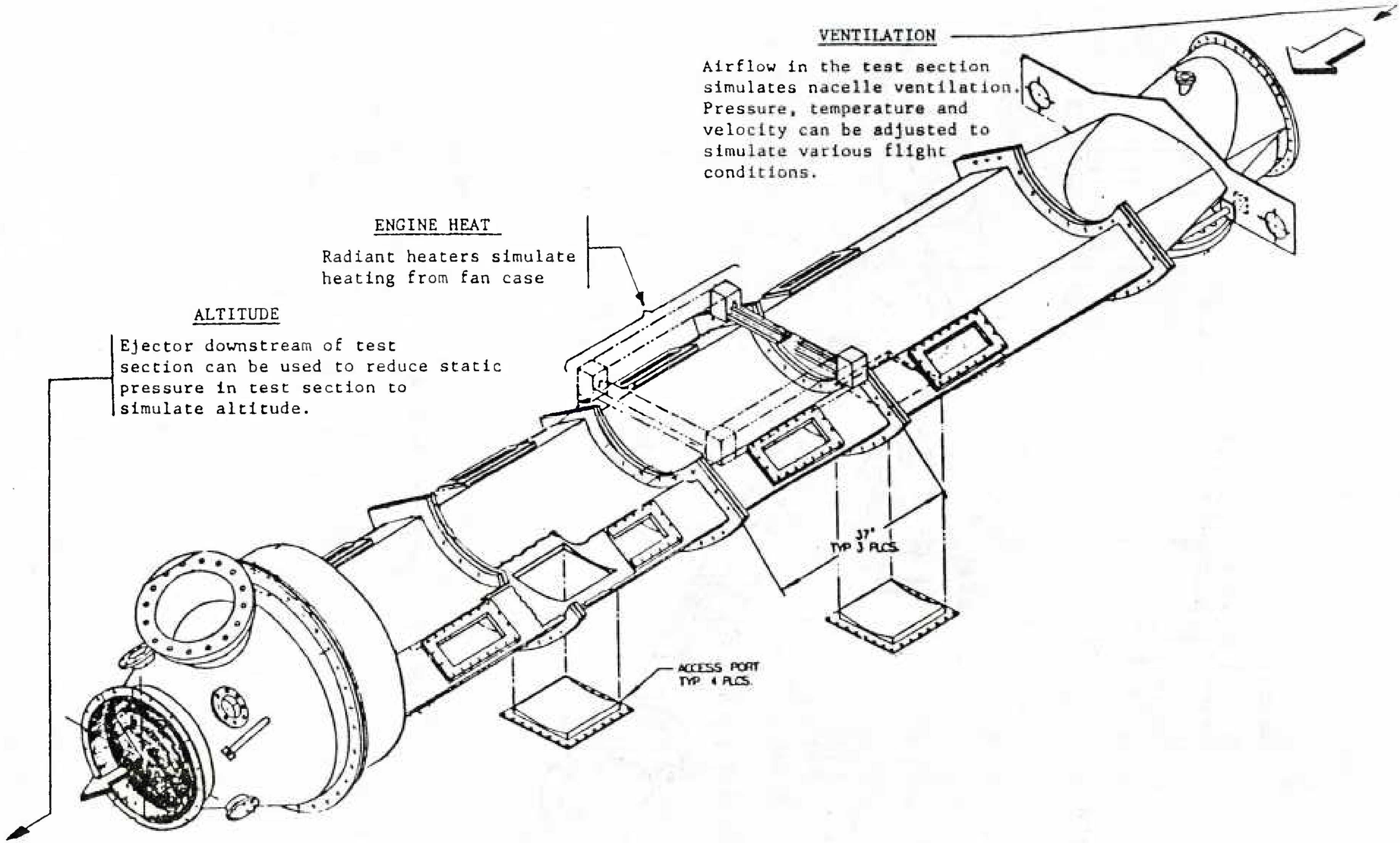



Figure 2-2. AEN Test Section Systems

Components of the high pressure air system are shared with the Simulated Aircraft Fuel Tank Environment (SAFTE) test facility, also located in I-Bay of Building 71-B. Because of scheduling conflicts, these components were not available for use in AEN tests discussed in this report. Consequently, this testing was limited to engine compartment ventilation airflow conditions which could be simulated using the atmospheric blower.

Simulation of the hazards associated with hot engine bleed ducts and the leakage which might result from damage to bleed air ducts or the engine case is provided by the AEN bleed air heating system. A natural gas fired heater, mounted on the roof of the AEN test cell, heats incoming high-pressure air from the bottle farm and provides automatic control of flowrate and temperature. Temperatures from ambient up to $1500^{0}$F can be simulated at flowrates up to 1 pound per second.

To conserve bottle farm high-pressure air, shop air is used during the start-up pre-heating of this system and between test conditions. Up to 40 minutes is required to pre-heat the system and the piping which delivers the hot bleed air to the AEN test section when the highest bleed air temperatures available are selected.

An insulated flex duct delivers heated simulated engine bleed air to the AEN test section. This air was ducted into the F-100 engine right-side bleed air ducting in the existing F-16 nacelle simulator, but the ducting and test section position could be arranged to deliver this flow to any part of the forward two 36-inch test sections (zones 1 through 4) of the AEN. The complexity of the radiant heater installation on the engine side of the test section makes routing of the bleed air through that surface more difficult than entry through the test section sides or through the larger radius which simulates the engine compartment outer wall.

A schematic diagram of the bleed air heater system is shown in Figure 2-3. A detailed discussion of the design, arrangement and operation of this system and of other parts of the AEN are included in the AEN Operation Manual (Ref. 4).

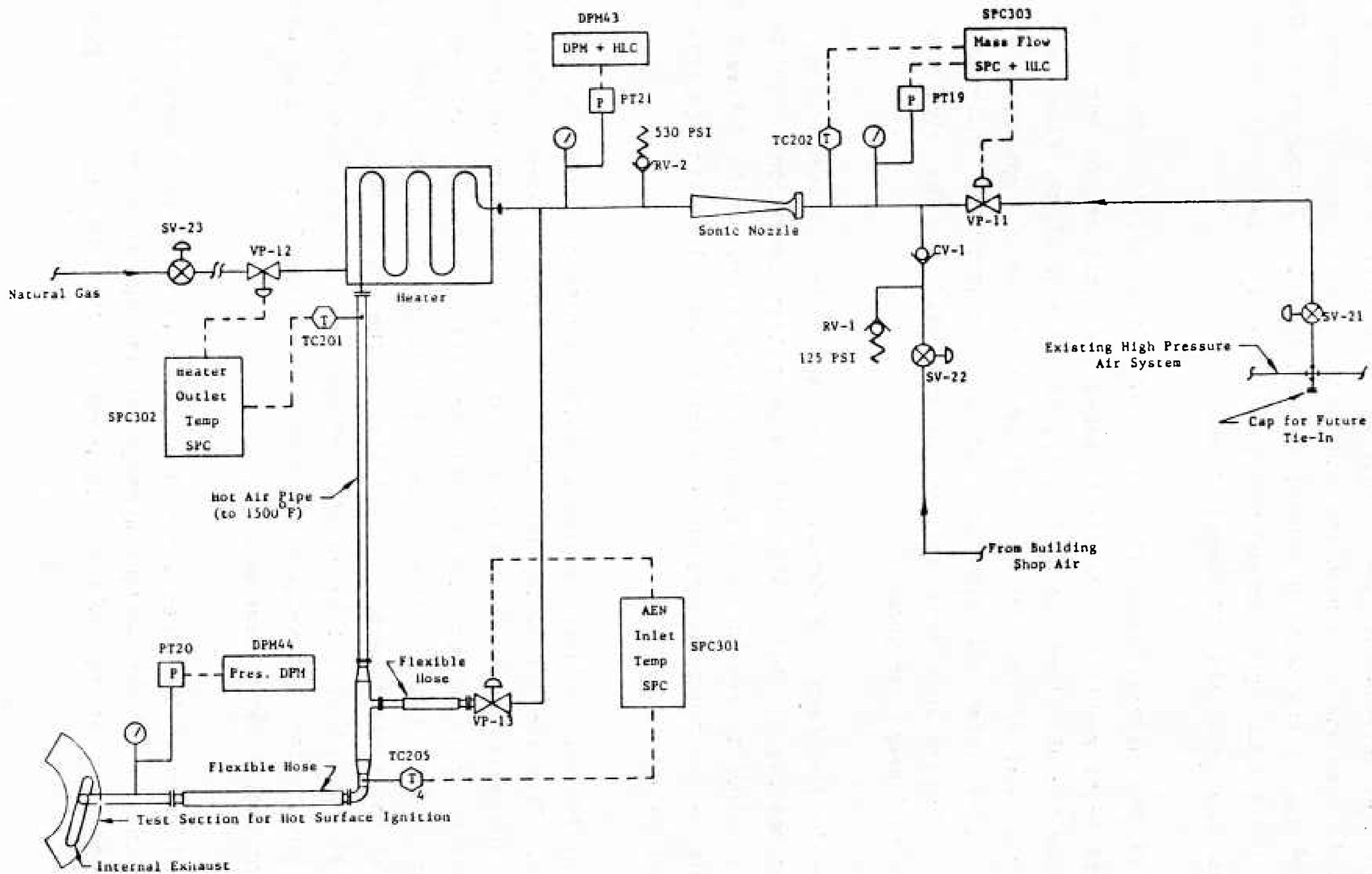



*Figure 2-3. Bleed Air Heater System Schematic*

## 3.0 TEST ARTICLE

Two basic test articles were used; a clean nacelle for baseline tests and a F-16 nacelle simulator. Both articles were used for agent distribution and the F-16 was used for battle damage tests.

### 3.1 Baseline Fire Test

Fire tests were conducted on the clean nacelle and the F-16 nacelle simulator to establish baseline data for subsequent damage simulation tests.

#### 3.1.1 Clean Nacelle Baseline

A typical aircraft engine compartment contains accessories, plumbing, and wiring aircraft structure. The obstructions make airflow patterns in these compartments extremely difficult to predict. To acquire baseline data concerning agent performance in combating engine compartment fires, it was considered desirable to minimize uncontrolled test variables during the initial test. A simple flameholder, flammable fluid injection system and igniter used for the Nitrogen Enriched Air (NEA) testing during 1981 (see Appendix B) were employed. These components, which are illustrated in Figure 3-1, were installed in the AEN as they had been positioned for the NEA testing with the test section oriented in the 4 o'clock to 8 o'oclock position (with the engine side upward). It was anticipated that these components would provide a minimum disturbance in the AEN ventilation airflow and that the Halon distribution piccolo-tube would provide uniformly distributed Halon concentrations throughout the AEN test section. A 4-inch by 12-inch VYCOR window in the left side of the AEN (looking aft), even with the flameholder, allowed observation of the fire activity using the AEN TV camera and color monitor in the control room. Stainless steel atomizing spray nozzles were employed to spray the flammable fluid onto the flameholder for all baseline and F-16 nacelle simulator fire tests. These nozzles and their flow rates are identified in Table 3-1.

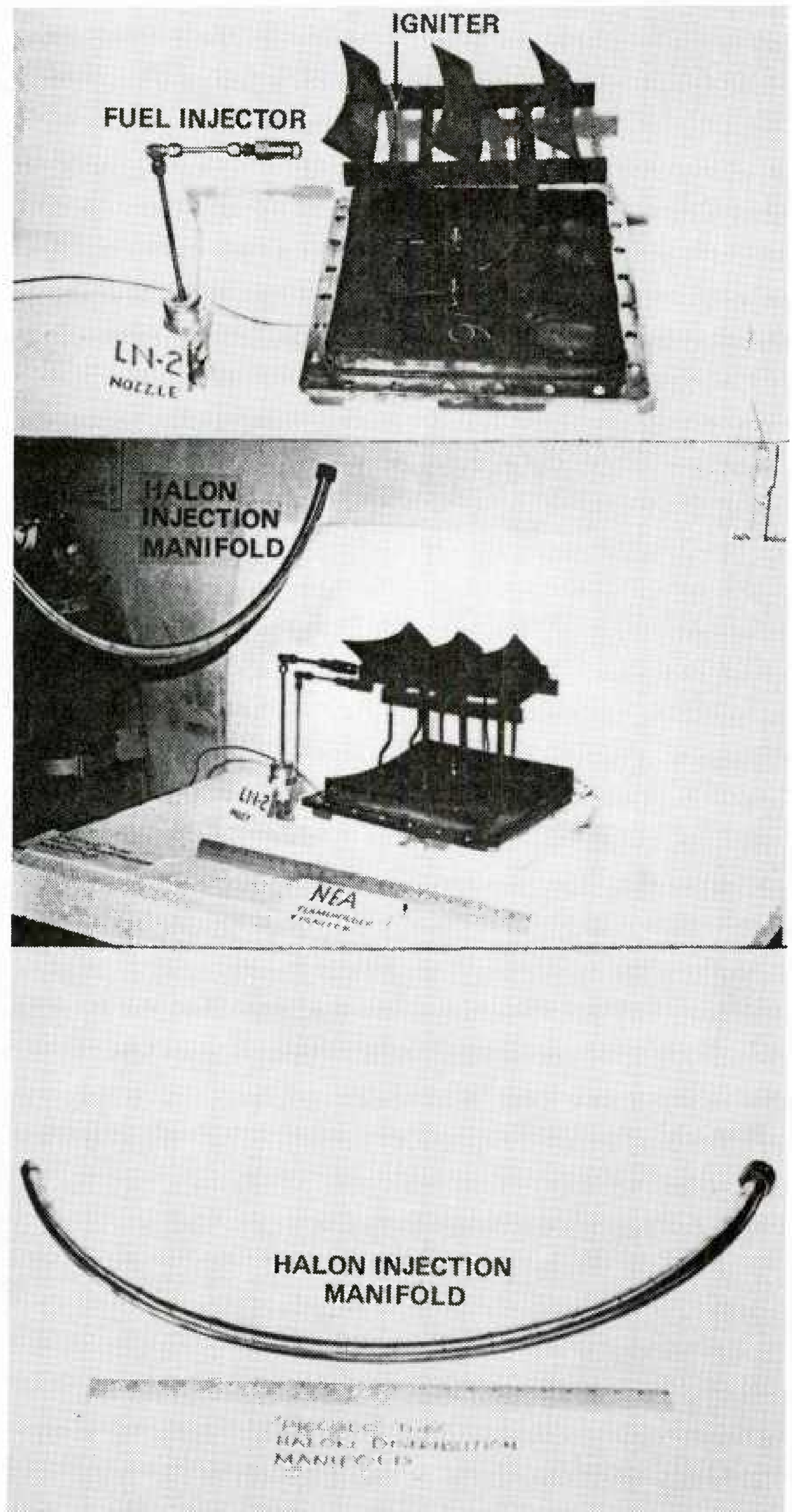



*Figure 3-1. NEA Flameholder, Igniter, Injector and "Piccolo-tube" Halon Injection Manifold*

Table 3-1 Fuel Injection Nozzle Flow Rates

| Nozzle I.D. No. | Orifice Diameter (Inches) | Flow Rate at 160* psig | | | |
| --- | --- | --- | --- | --- | --- |
| | | Water | JP-4 | MIL-H-5606 | MIL-H-83282 |
| LN2 | .028 | .113 | .128 | .122 | .123 |
| LN4 | .042 | .170 | .192 | .183 | .183 |
| LN8 | .06 | .250 | .283 | .270 | .273 |
| LN14 | .076 | .460 | .521 | .496 | .501 |
| LN26 | .086 | .920 | 1.042 | .992 | 1.004 |

All nozzles are stainless steel hollow core atomizing spray type with 80 degree nominal spray angles.

* 160 psig is normal nozzle pressure when fuel reservoir is a 175 psig.

Testing prior to September 1983 used an existing Halon 1301 measurement and dump system where the Halon was stored in a container that was suspended from a load cell and capable of holding about 150 pounds of agent. The agent was injected under 350 psig nitrogen pressure through interchangeable orifices, for a period controlled by a pulse timer. The agent traversed about 16 feet of 1-inch flex-line before escaping into the AEN through the piccolo-tube. This system is shown in Figure 3-2. Agent quantity was monitored both by the change in the container weight and by calibration of the orifices over many similar dump events using the same load cell.

This Halon 1301 dump system was incompatible with Halon 1202. However, the lower vapor pressure of Halon 1202 (14.7 psia at 73 $^{o}$F) could cause it to collect as a liquid in the long delivery tube. Because a substantial, but variable, portion of the Halon charge might not reach the AEN test section, consistent test results were not obtained.

Consequently, a new dump system was developed for Halon 1202 similar to an aircraft dump system. The volume of agent was measured in a pressurized sight-gage and moved under pressure in a small dump tank set directly above the AEN. The dump tank was than pressurized with nitrogen to 600 psig prior to agent release into the test section. A short vertical 1-inch delivery tube led to the piccolo-tube distribution manifold as is shown schematically in Figure 3-3 and in the photograph on Figure 3-4.

A range of dump tank sizes was employed to maintain a fill ratio (Halon to nitrogen, by volume) of about 50% in the dump tank as in normal aircraft practice. During actual testing, the fill ratio did not significantly affect the test results if the Halon charge occupied between 25% and 50% of the dump tank volume; thus frequent tank size changes were not required.

With this new close-coupled system, it was feasible to vary the agent volume with each test event. Accuracy was improved because the ventilation airflow rate was not varied from condition to condition.

Results obtained with this system, using Halon 1202, differed so greatly from the results obtained with Halon 1301 in the original system that modifications were undertaken to allow use of the new close-coupled system with Halon 1301.

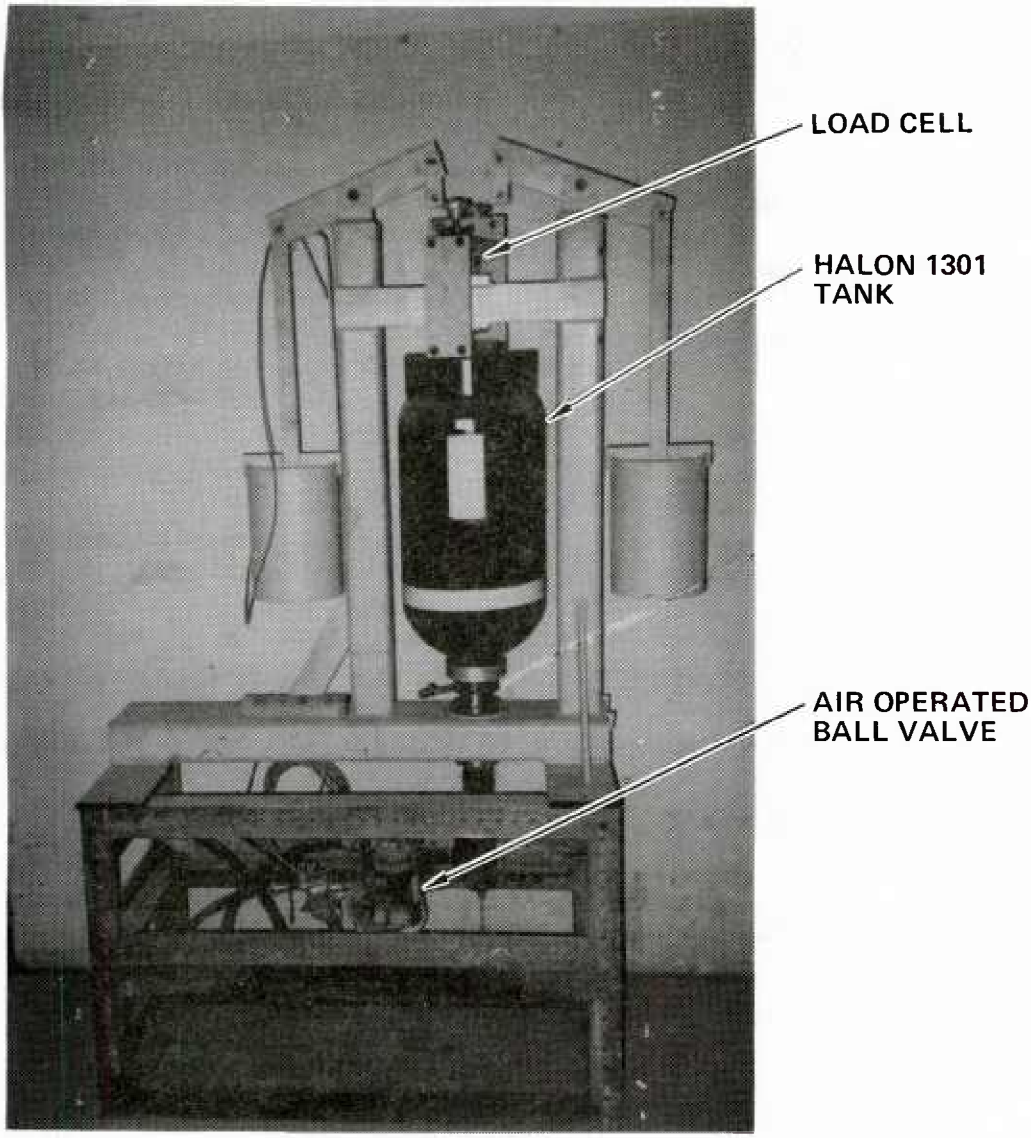



*Figure 3-2. Remote Halon 1301 Dump System*

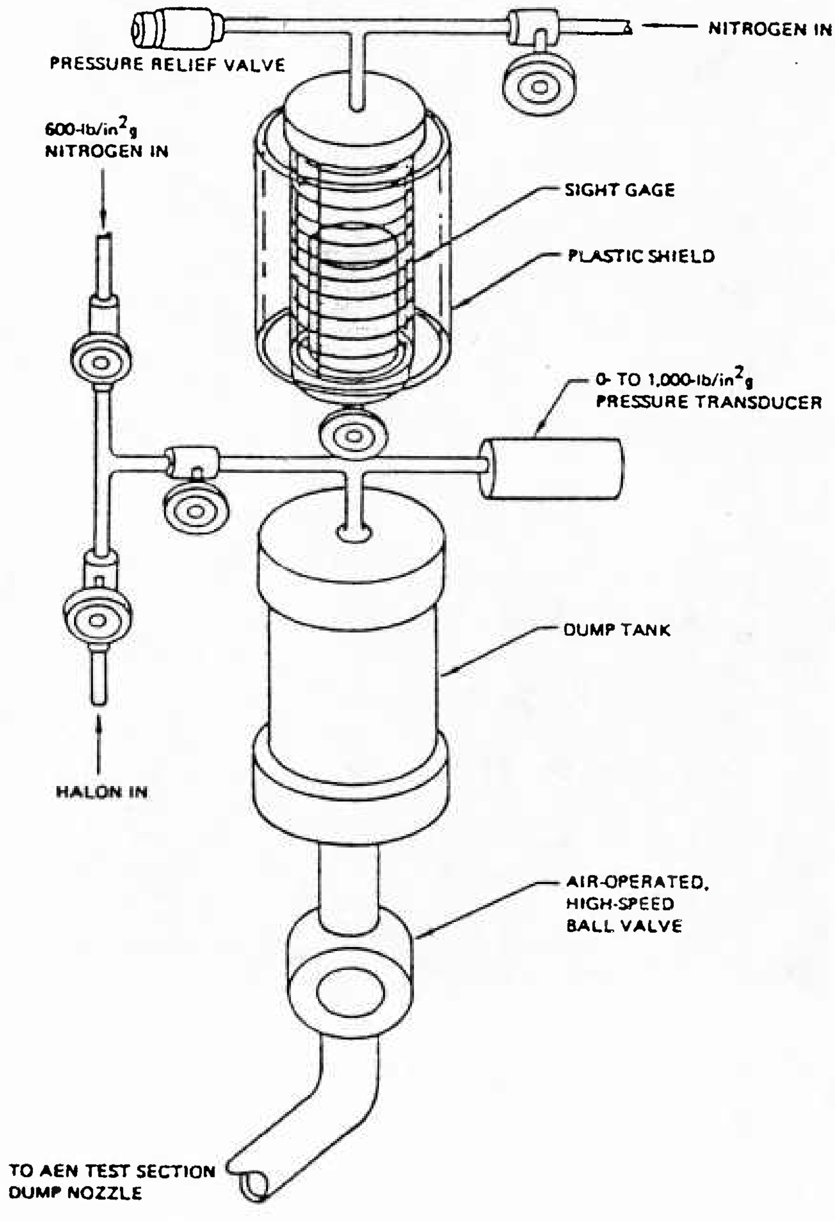



*Figure 3-3. Diagram of Halon Fill, Measurement and Dump System*

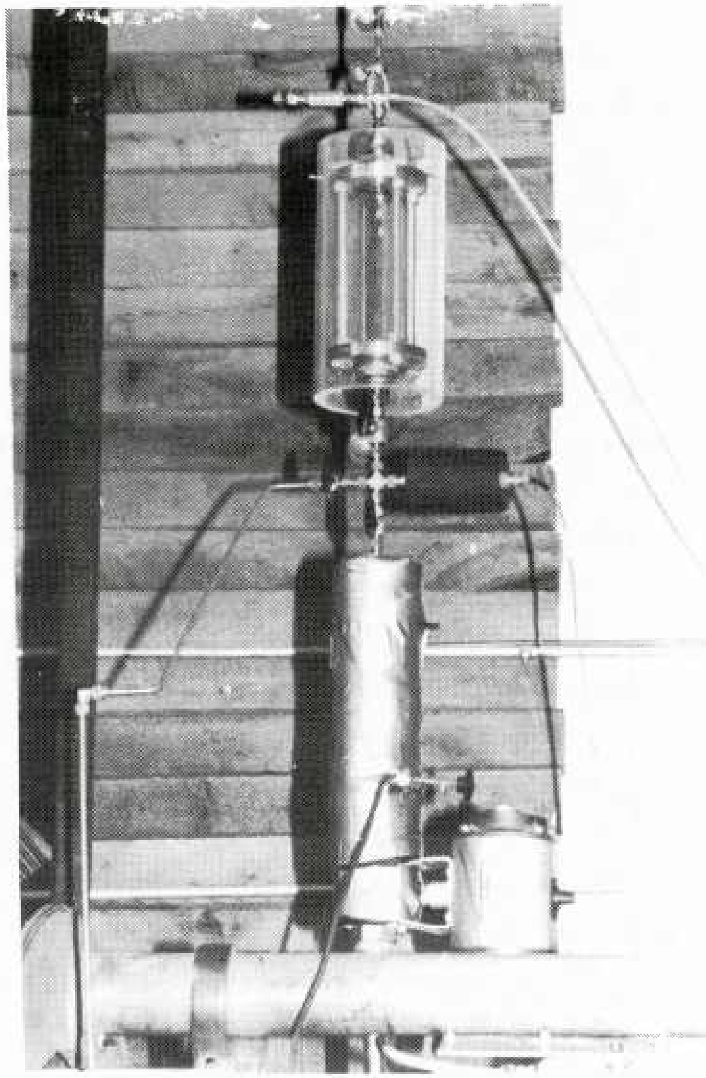


*Figure 3-4. Photograph of Halon Fill, Measurement and Dump System*

These consisted of adding burst protection around the sight gauge and changing pressure regulators and procedures for the Halon fill and measurement operation to correspond to the much higher vapor pressure of Halon 1301 (161 psi at 50$^{0}$F).

Because of the much higher vapor pressure of Halon 1301, it was found to be necessary to cool and insulate and cool the dump tank. (The earliest attempts to fill the dump tank failed because the Halon 1301 would immediately expand allowing only a small amount of the agent to enter the tank.) This was done by wrapping a coil of copper tubing around the dump tank through which a small amount of Halon 1301 was vented to the atmosphere. A manual valve on this line was adjusted to maintain a minimal flowrate which could be monitored visually by observing the Halon discharge against a lighted background. Foam insulation was taped over the outside of the cooling coil and around the top and bottom of the tank. The toxicity of Halon 1202 would have precluded such a procedure for that agent. However, cooling was not required for Halon 1202. Because Halon 1301 is much less toxic and because the test cell low point and smoke exhaust systems were always operated during Halon fill and dump operations, the cooling procedure was considered safe.

First tests were repeated with this higher-pressure close-coupled system using Halon 1301, and the results were substantially different from those obtained with the original system. With shorter, higher intensity pulses, the Halon seemed more effective as an extinguishant. Since this system was more representative of typical aircraft dump systems, it was employed thereafter for all testing.

### 3.1.2 F-16 Nacelle Simulator

In an actual engine compartment, the ventilation airflow does not move uniformly as in the clean AEN test section. Regions of reverse flow and flow stagnation have been seen in the F-111 being tested by the FAA at the FAA Technical Center; the F-111 engine compartment is cleaner and designed for higher ventilation airflow rates than the F-15 and F-16 engine compartments. To examine the changes in agent performance when the agent was discharged onto a fire in a compartment having the complex of tubes, ribs, clamps, wires, and other flow disturbances of a real aircraft engine compartment, a region of the F-16 nacelle was simulated.

The forward right side of the F-100 engine as installed in the F-16 is shown in Figure 3-5. A scrap early prototype F-100 engine was obtained and the components in this region were removed and installed on a 5-foot long simulated engine-side stainless steel base-plate constructed to fit the engine-side of the AEN test section. This assembly is shown in Figure 3-6. Intrusion into this region of the glove tank and structural ribs was simulated in sheet metal and fitted into the AEN test section over the engine-side base-plate. The final assembly, representing one third of the engine compartment annulus, is shown in Figure 3-7. The remaining AEN test section length, approximately 60 inches, simulated the less cluttered annulus around the afterburner.

To further simulate the F-16 installation, the AEN test section was rotated to the 7 o'clock to 11 o'oclock position (looking aft). A viewing window was provided in the 15-inch square access port on the nacelle side of the AEN which opened onto the forward "arch" of the F-16 bleed duct which was the planned fire zone. The original pyrex window was replaced by fused quartz because the pyrex section was unable to withstand the temperatures after several weeks of fire testing. Figure 3-8 shows the viewing window with the glass removed. This photograph was taken near the completion of the combat damage tests; distortion of the bulkhead between the fire zone and the glove tank region due to the number of fires and the severity of some of them is visible.

In the F-16, ventilation air enters the engine compartment through a scoop inlet on each side adjacent to the fan-face of the engine and in some operating conditions, through spring loaded fire doors near the base of the engine compartment, about 18 inches aft of the scoops. These were simulated with an inlet baffle plate at the fan face location with slotted openings approximating one-third of the area of the aircraft nacelle ventilation inlets and fire doors. A baffle plate was also placed at the exit end of the last AEN test section to simulate the flow area in the F-16 engine compartment as the ventilation flow exists around the afterburner.

To simulate an aircraft Halon dump system, a single Halon distribution nozzle was installed in place of the piccolo-tube Halon distribution manifold. This consisted of a 1-inch diameter, 45 degree AN bulkhead fitting installed in the top forward corner of the nacelle simulator pointing down and aft at 45 degrees. This was attached to the simulated Halon dump-tank by a short, nearly vertical, delivery tube.

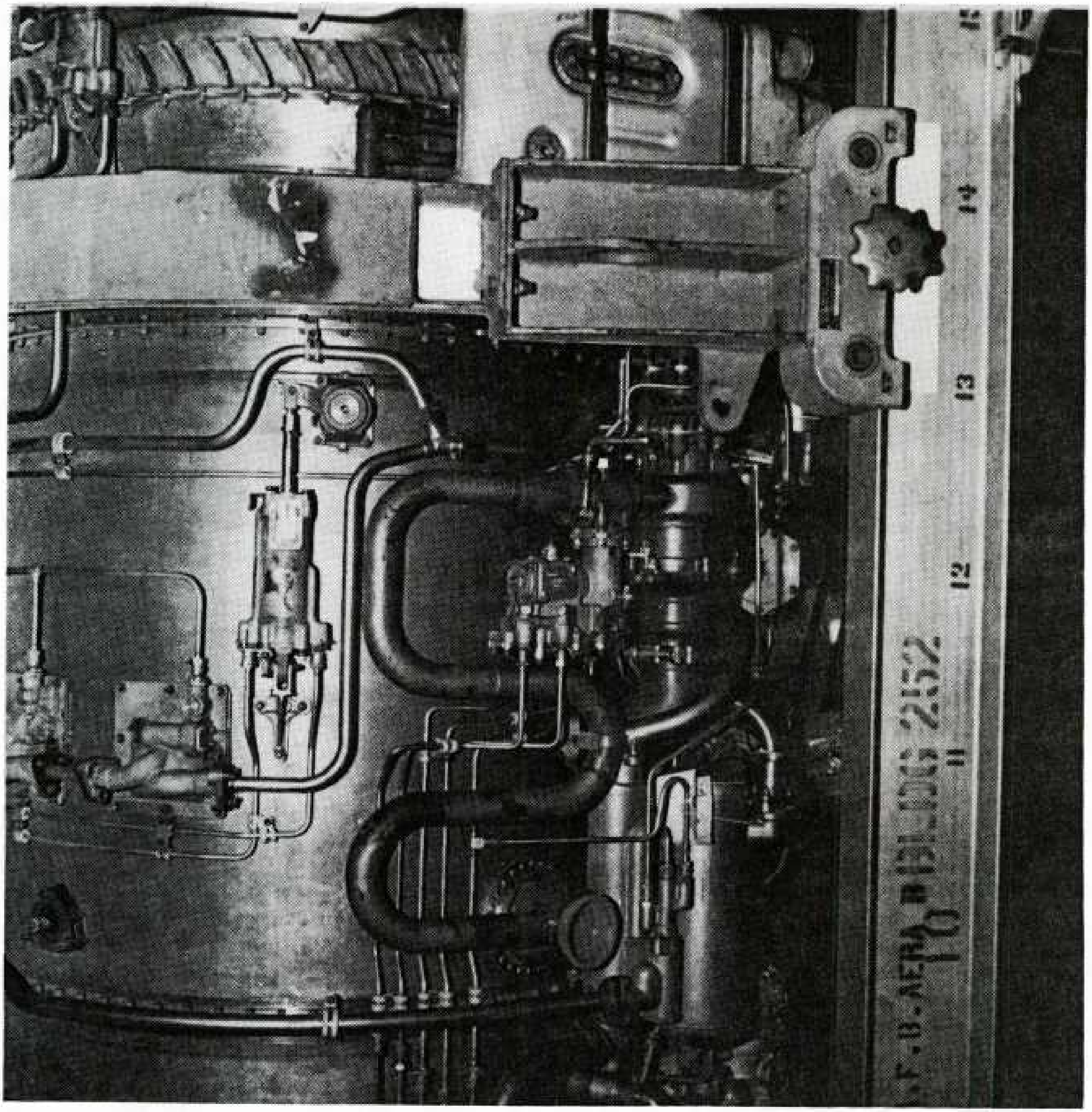


*Figure 3-5. F-100 Engine Showing Engine Accessories to be Installed on F-16 Nacelle Simulator*

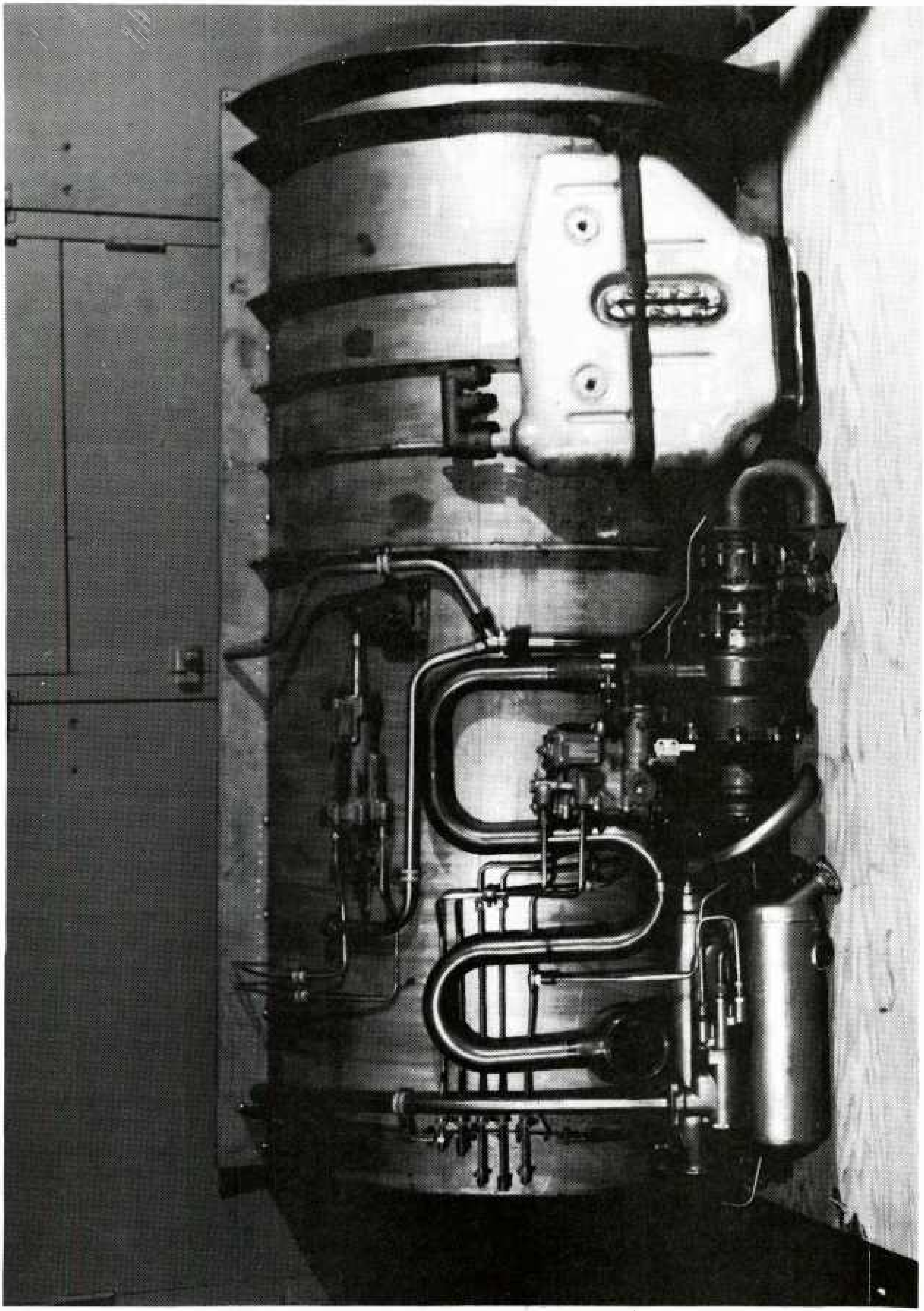


*Figure 3-6. Engine Components, F-16 Simulator*

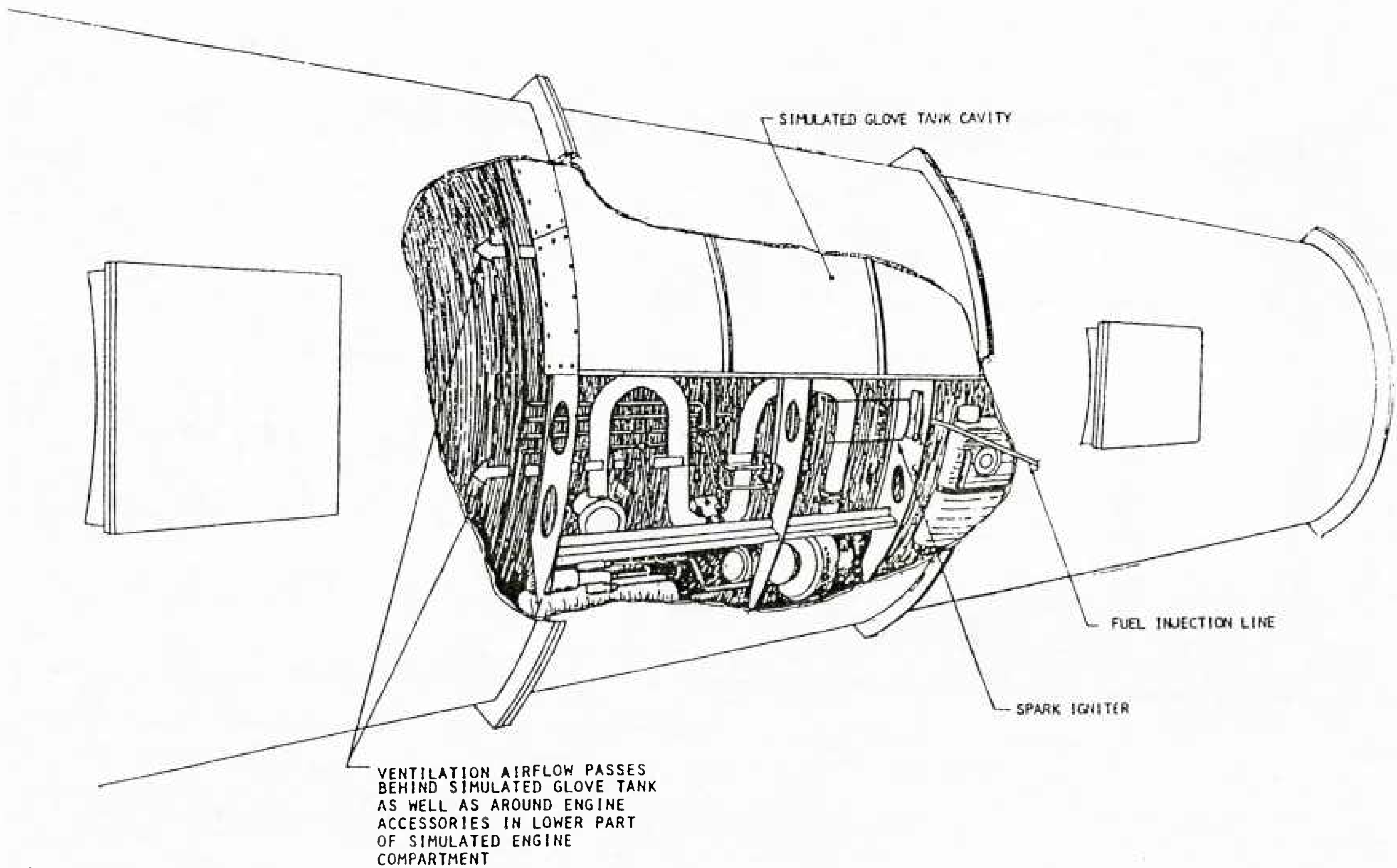



*Figure 3-7. Cutaway Diagram of F-16 Nacelle Simulator*

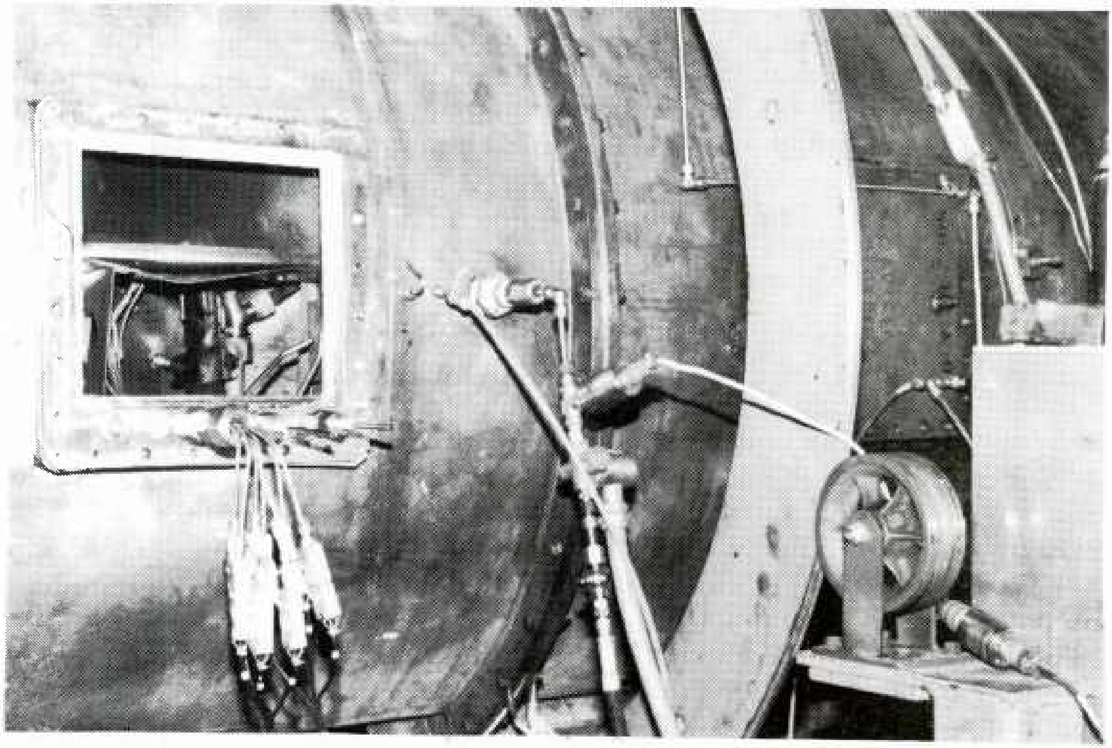


*Figure 3-8. F-16 Nacelle Simulator Installed in AEN Test Section*

When the F-16 nacelle simulator was installed in the AEN, it was determined in initial checkout runs that simulator airflow was less than desired. With both the atmospheric blower and the scrubber exhaust fan running at their maximum, the ventilation airflow rate was 5.9 pounds per second. To provide for higher flow rates, thereby making the test data applicable to other aircraft with higher ventilation flowrates, such as the F-111, both inlet slots were opened up by one-third. This provided a maximum of about 7.5 pounds per second.

During initial fire tests with JP-4, it was discovered that the airflow velocity around the F-16 bleed duct was too high to enable starting a fire above 1 pound per second and that these fires would be blown-out by ventilation airflow at 2 or 3 pounds per second. After some experimentation, the igniter and fuel injection nozzle were relocated into the shelter of the simulated aircraft rib structure adjacent to the leading edge of the viewing window. Reliable, stable fires still could not be ignited and maintained at the higher velocities until a simple "vee-channel" flameholder was developed which enclosed the fuel nozzle and the igniter. This installation is shown in Figure 3- 9.

### 3.1.3 U-V Fire Detection System Installation

A portion of the Graviner ultraviolet aircraft fire detection system that was developed for flight testing on the F-111 aircraft under contract F33615-77-C-2029 was installed with the F-16 nacelle simulator. This system, as configured for the F-111, employed a series of either single or double bulb detector heads, a computer control unit (CCU), a cockpit mounted crew warning unit (CWU), and a ground support equipment (GSE) memory interrogation unit. Detailed descriptive information concerning this system is available in Ref. 5.

In the AEN installation (Figure 3-10), a single bulb detector unit was mounted on the aft side of the inlet baffle, just below the inlet slot, where it would not be subjected to fires or elevated temperatures. This unit consisted of a single photocell in a protective quartz dome and a single emitter cell. The CCU, located adjacent to the AEN, periodically fired the emitter, checking that the photocell observed the U/V burst and thereby could indicate a fire or else it would cause a system failure warning to appear on the CWU. The CWU was mounted on the side of the viewing window where the warning lights could

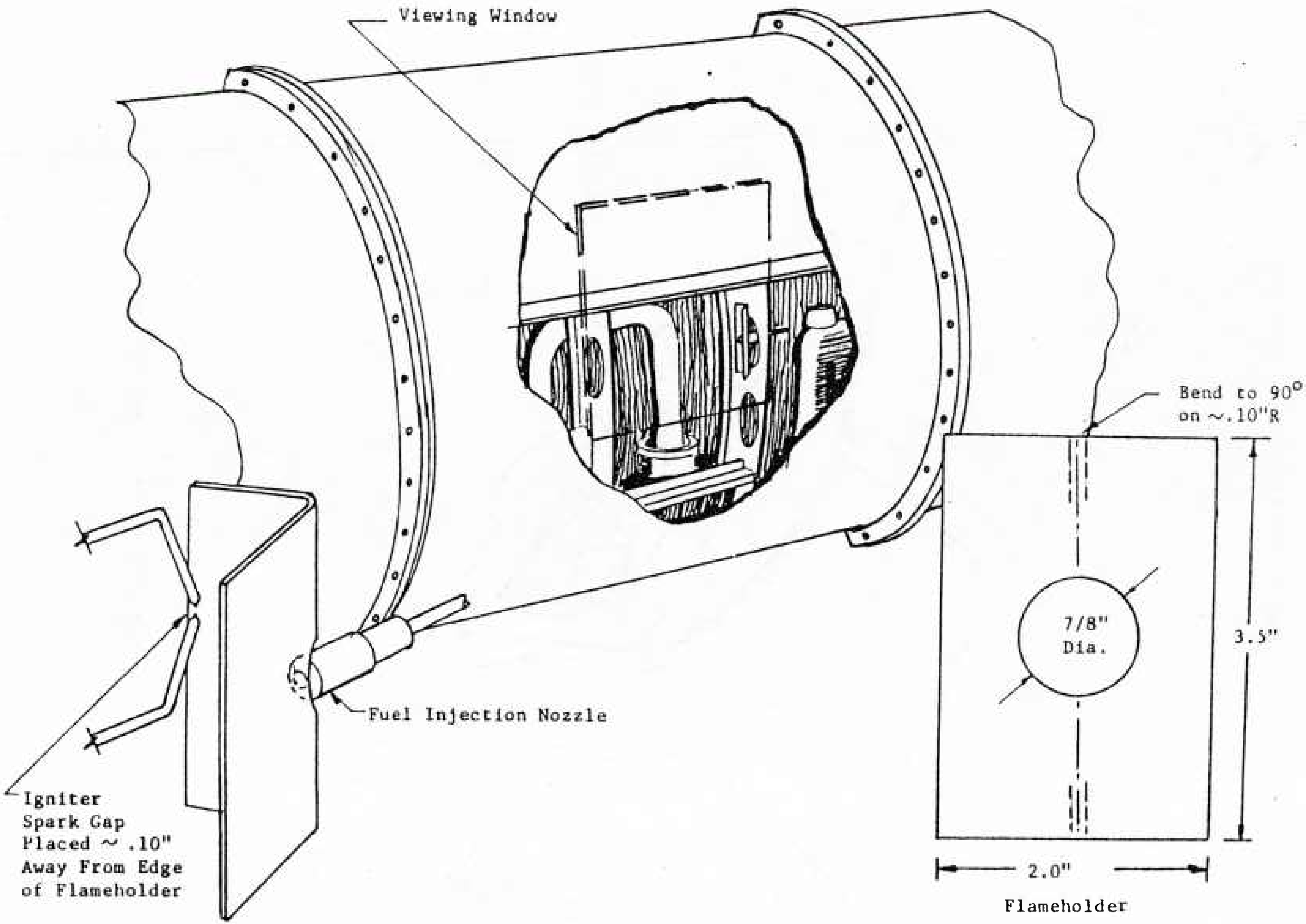



*Figure 3-9. Fuel Nozzle, Flameholder and Igniter Installation with F-16 Nacelle Simulator*

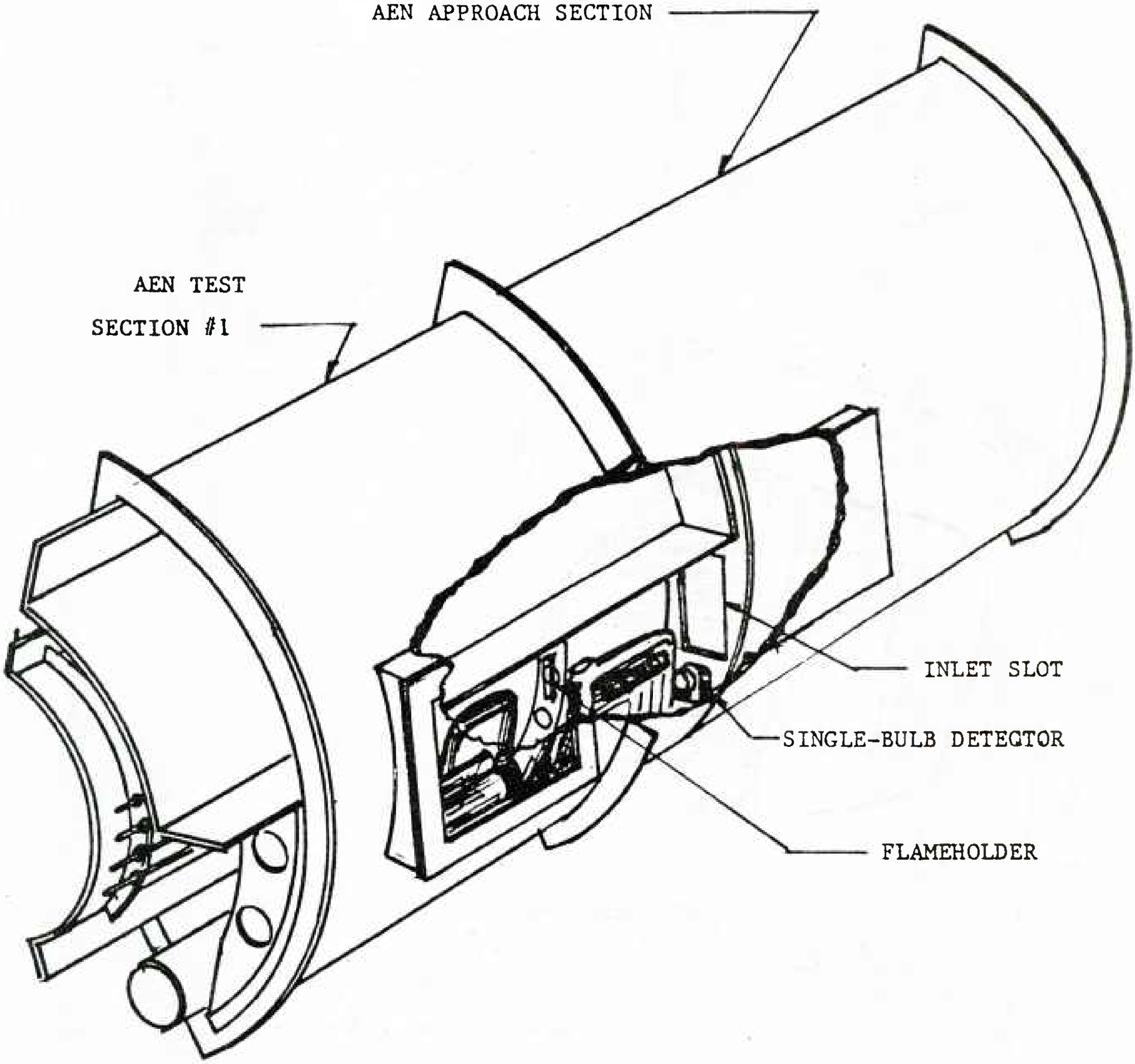



*Figure 3-10. UV Fire Detector Installation*

be observed by the test engineer on the AEN color TV monitor during fire tests. The GSE was intended for post flight system interrogation and was not used in the AEN installation.

## 3.2 Baseline Agent Concentration Tests

The baseline agent concentration tests were conducted to determine agent distribution patterns in intact nacelles for comparison with distribution in nacelles with simulated battle damage.

### 3.2.1 Clean Nacelle Baseline

The test article for the agent concentration tests in the clean nacelle was unchanged from the fire tests except that there was no flammable fluid injected, the igniter was not operated, and six Halon concentration probes were inserted into the test section. These probes consisted of 36-inch lengths of 0.085 inch I.D. stainless tubing supported by 1/4-inch stainless tube sleeves and were designed to connect to the plastic inlet tubes provided with the Beckman Halonizers.

The probes were inserted through an aluminum plate that replaced the viewing window adjacent to the flameholder on the left side of the AEN (looking aft). They were arranged so that two were in the fire zone and the other four were positioned to the left side. One fire zone probe was near the front of the flameholder and one was just aft of the flameholder. Two of the other probes were located even with the front of the flameholder near the center of equal areas on the left side of the nacelle, and two were in similar positions even with the aft end of the flameholder. These locations and the details of the probe construction are shown on Figure 3-11.

### 3.2.2 F-16 Nacelle Simulator

The arrangement of the Halon concentration probes in the F-16 nacelle simulator differed from the clean nacelle installation in that two were located high in the cavity behind the glove tank, two were in the fire zone, and two were deep in the clutter at the base of the nacelle. Details are shown in Figure 3-12.

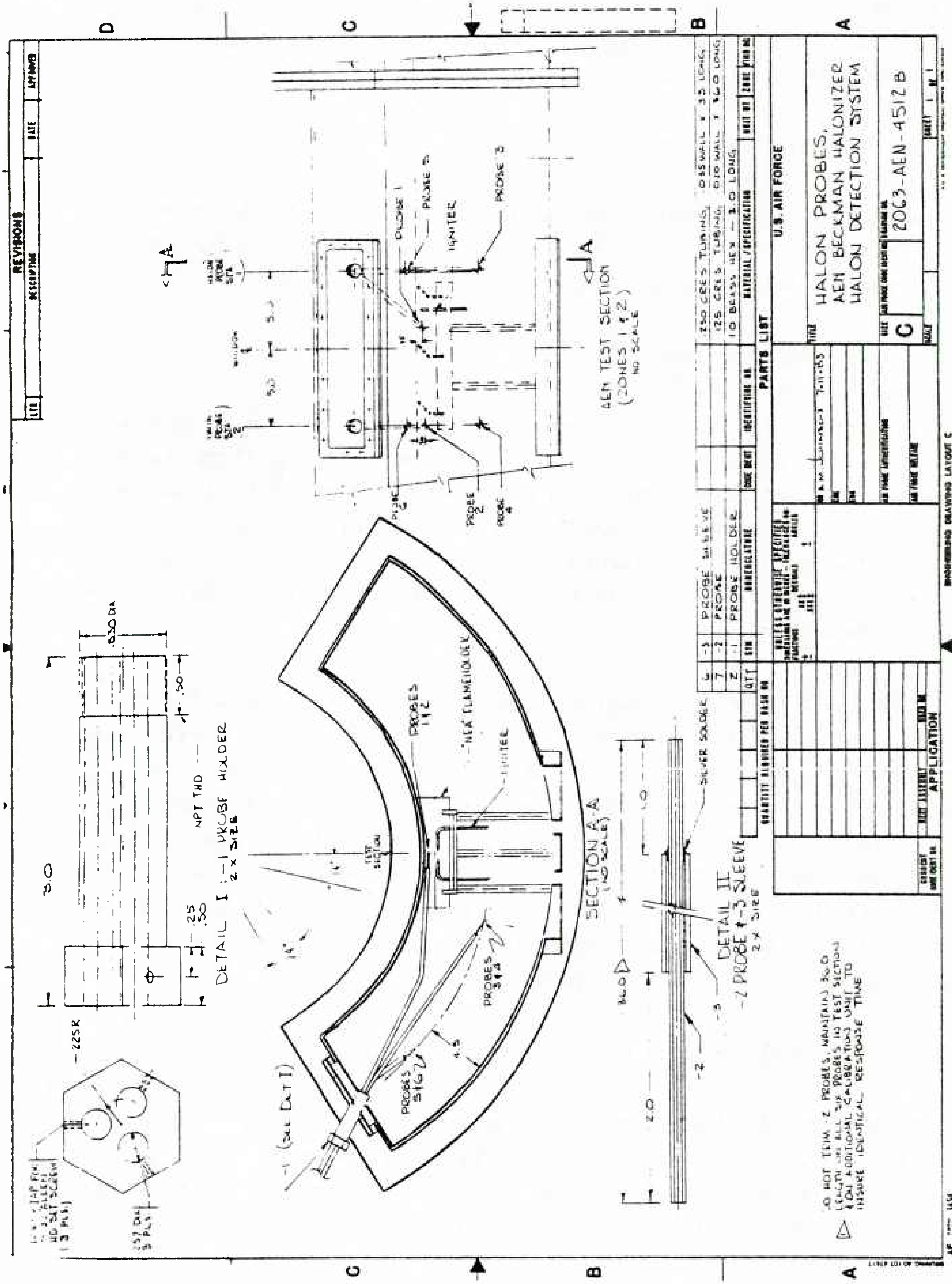



*Figure 3-11. Halon Probes for Clean Nacelle Baseline*

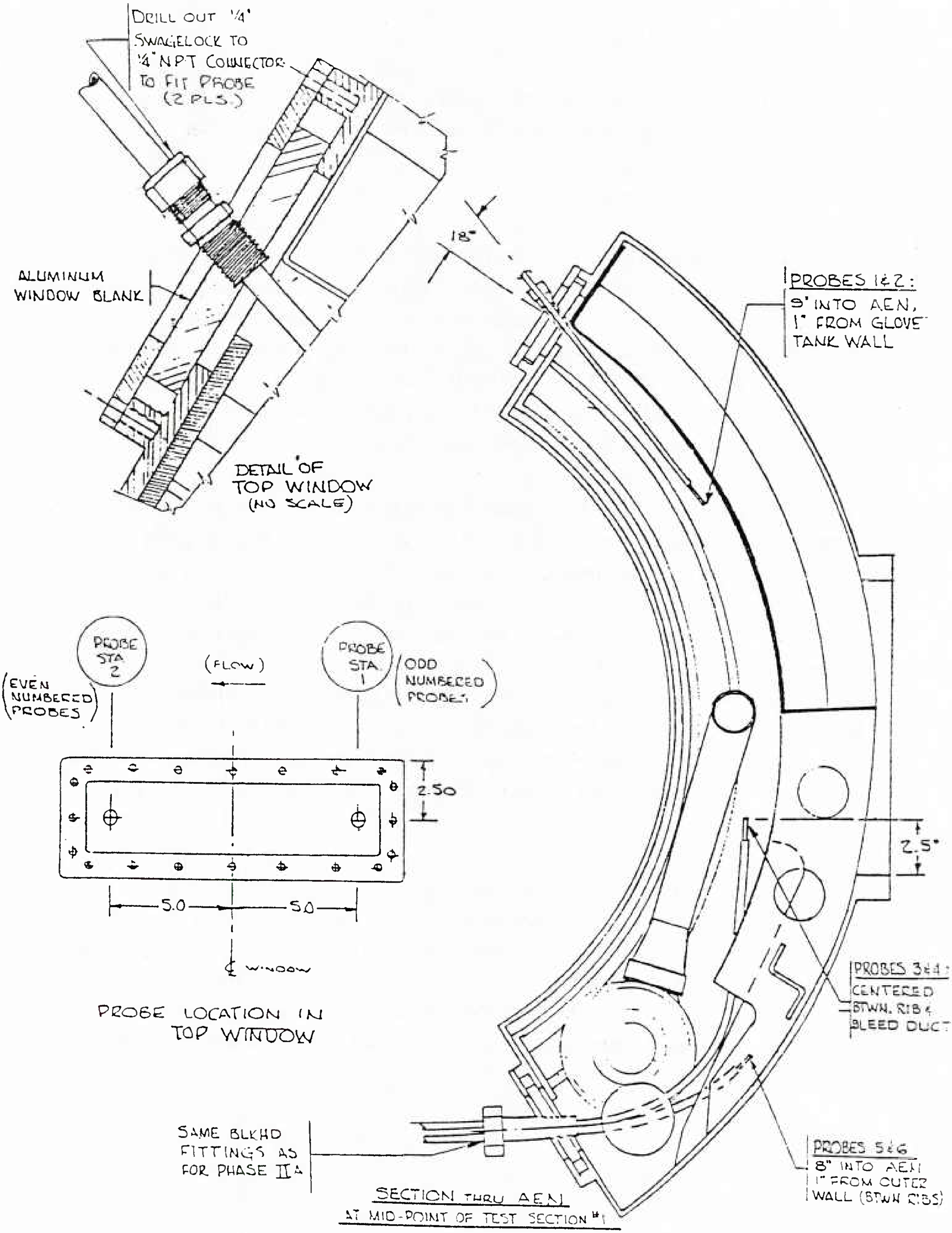



*Figure 3-12. Halon Probes for F-16 Nacelle Simulator*

### 3.3 Combat Damage Fire Tests

Tests were conducted to simulate combat damage with both inflow of the external air stream or outflow of Halon and ventilation air.

#### 3.3.1 Outflow Fire Tests

As indicated in Appendix C, a 23 mm HEI burst within the engine compartment of an F-16 might result in a "flower" shaped hole in the compartment outer wall. This hole might increase or decrease the compartment ventilation airflow depending on its shape and location and on the flight condition and aircraft altitude. It was decided to evaluate the conditions resulting in outflow in the F-16 nacelle simulator by simulating a jagged hole caused by a 23 mm HEI in the wall of the glove tank bulkhead immediately above the fire zone.

The simulated hole was based on results of gun fire tests in the AFWAL Flight Dynamics Laboratory gun range (Ref. 2) in which 23 mm HEI projectiles were fired into closed compartments. The projectiles would burst a few inches inside the compartment leaving a flower type hole in the compartment wall. Photographs of these HEI flowers from Ref. 2 were used as a pattern for a template to cut a similar shaped opening in a 10-inch square, 0.0625-inch thick, stainless steel panel. The jagged edges of the flower were bent outward to simulate the photographs as closely as possible. This panel was then fastened over an 8.5-inch square opening provided in the glove tank wall. Figure 3-13 shows the flower panel and Figure 3-14 shows it installed on the glove tank wall.

Provision had been made in the nacelle simulator construction to allow adjustment of baffles at the glove tank exit to tune the flow exiting through the HEI flower to about 40% of total ventilation flow entering the test section. As indicated in Section 7.0, a pitot probe traverse of the F-16 simulator, just aft of the flower panel indicated that about 40% of the total ventilation flow was escaping through the flower, as planned, with all the exit baffles removed.

The flameholder, igniter, fuel injection system and Halon injection system were unchanged from the baseline F-16 nacelle simulator fire tests.

*Figure 3-13. Simulated HEI "Flower" Panel*

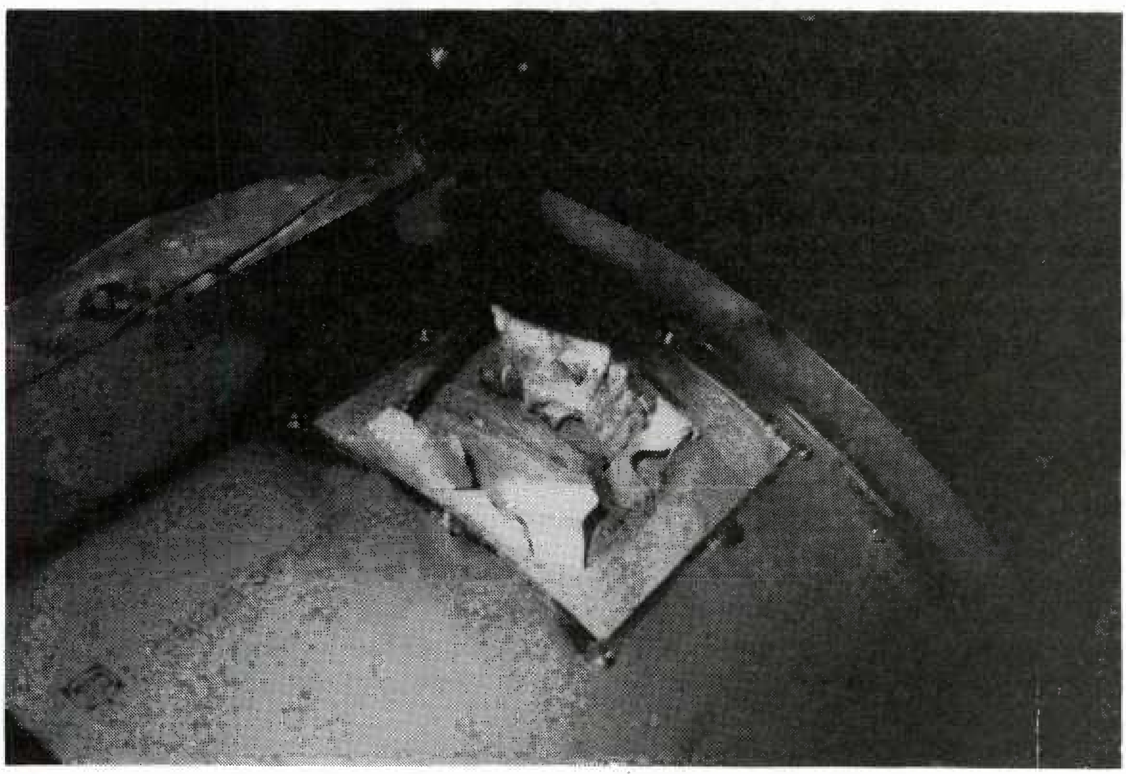


*Figure 3-14. Simulated HEI "Flower" Panel Installed in Glove Tank Wall*

### 3.3.2 Inflow Fire Tests

In some situations combat damage could increase the amount of airflow in the engine compartment of an F-16 (Appendix C). These included external air entrained by a wound in the compartment outer wall, fan perforation and bleed duct separation or perforation. To introduce this additional air into the F-15 nacelle simulator, it was decided to employ the bleed air heater system which had been developed for bleed duct not surface ignition testing.

While the airflow provided by this system was limited to 1 lb/sec, Appendix C indicated that the higher airflows which might result from total bleed duct separation would not represent the greatest fire hazard and that 1 lb/sec would probably be an acceptable simulation. The ability to heat this airflow to any temperature up to 1500$^{0}$F provided a great advantage in simulating the fan and bleed duct leakage.

The bleed air heater system was designed and constructed so that this airflow was routed through the outer wall of the upstream AEN test section and connected to the aft end of the F-100 engine bleed duct at the outboard Marmon flange where the bleed line to the ECS would normally be connected. The inner flange, which would normally be connected to the engine, was blanked off. The simulated bleed flow then traveled forward through the right-side bleed duct to the flange where it would normally be connected to the augmentor fuel pump.

While each of these types of combat damage caused inflow that would probably enter the engine compartment at a different location and in a different direction, it was decided to simplify the testing by simulating all three types with air entering at the point where the forward end of the F-100 right-side bleed duct attaches to the augmentor fuel pump. The bleed duct was clamped about 1 inch away from the augmentor fuel pump and the entrance to the pump was blocked.

During earlier tests, the aft end of the bleed duct was located behind the flanges separating test sections 1 and 2. To allow the bleed delivery line to be installed, the entire F-16 nacelle simulator was moved about 2 inches forward in the test section so that a hole could be drilled in the test section outer wall without interference from the flanges. This probably had a negligible effect except for the portion of the test article visible through the viewing window.

Again, the flameholder, igniter, fuel injection and Halon dump system were unchanged from the baseline F-16 nacelle simulator test article.

The inflow tests produced much hotter fires than the earlier test phases and damage to the F-16 simulator became noticeable. The bulkhead separating the glove tank cavity from the fire zone began to warp severely. While small amounts of fuel and occasional small fires had been visible in this region during all previous testing, this damage allowed a significant part of the fire to extend upward into the cavity. Various patches and seals were constructed and installed on top of the bulkhead to seal tightly against the viewing window but all these warped almost immediately. Eventually, fire clay was packed into the space between the bulkhead and a seal plate. This fix is shown in Figure 3-8 and did keep most of the fire from spreading into the glove tank cavity.

These extremely hot fires also began to melt aluminum engine components. Since this probably caused only very minor changes of the airflow through the fire zone and in the nature of the local flameholders, no attempt was made to correct this problem.

### 3.4 Combat Damage Agent Concentration Tests

The same Halon probe locations were selected as had been used during the baseline F-16 nacelle simulator agent concentration tests for both the inflow and the outflow combat damage tests. These locations are shown in Figure 3-12.

# 4.0 INSTRUMENTATION

Instrumentation on the AEN simulator included standard flowmeters, pressure tranducers and thermocouples as well as probes for sampling Halon concentration, and other instrumentation.

## 4.1 Basic AEN Instrumentation

Basic AEN instrumentation consisted of the sensors employed to measure the various flowrates, the test section temperatures and pressure and the fuel reservoir and nozzle pressures. Figure 4-1 is a schematic of the AEN showing these sensors. When the bleed air heater sysem was added, additional sensors were added to measure air flowrate and temperature.

### 4.1.1 Pressure Transducers

Fourteen pressure transducers were used to acquire AEN pressure data. They were precalibrated by their manufacturers (Sensotec, Setra and MKS) with standards directly traceable to the National Bureau of Standards. Their calibrations were periodically checked during the test program using a dead weight tester. Details of the transducer ranges, sensitivities and accuracies are presented in Table 4-1.

### 4.1.2 Temperature Measurement

Thermocouples employed for AEN test data acquisition are identified in Table 4-2. Most of the thermocouples originally installed in the facility were wired directly to a room temperature junction box in the control room.

An ice-point junction was subsequently installed in the blower room when the room temperature junction was found to provide unacceptable noise for flow measurement data. Thermocouples employed to acquire data that were used in flow measurement calculations were connected to the ice-point junction along with a variety of additional thermocouples which were added after the ice-point reference junction was installed.

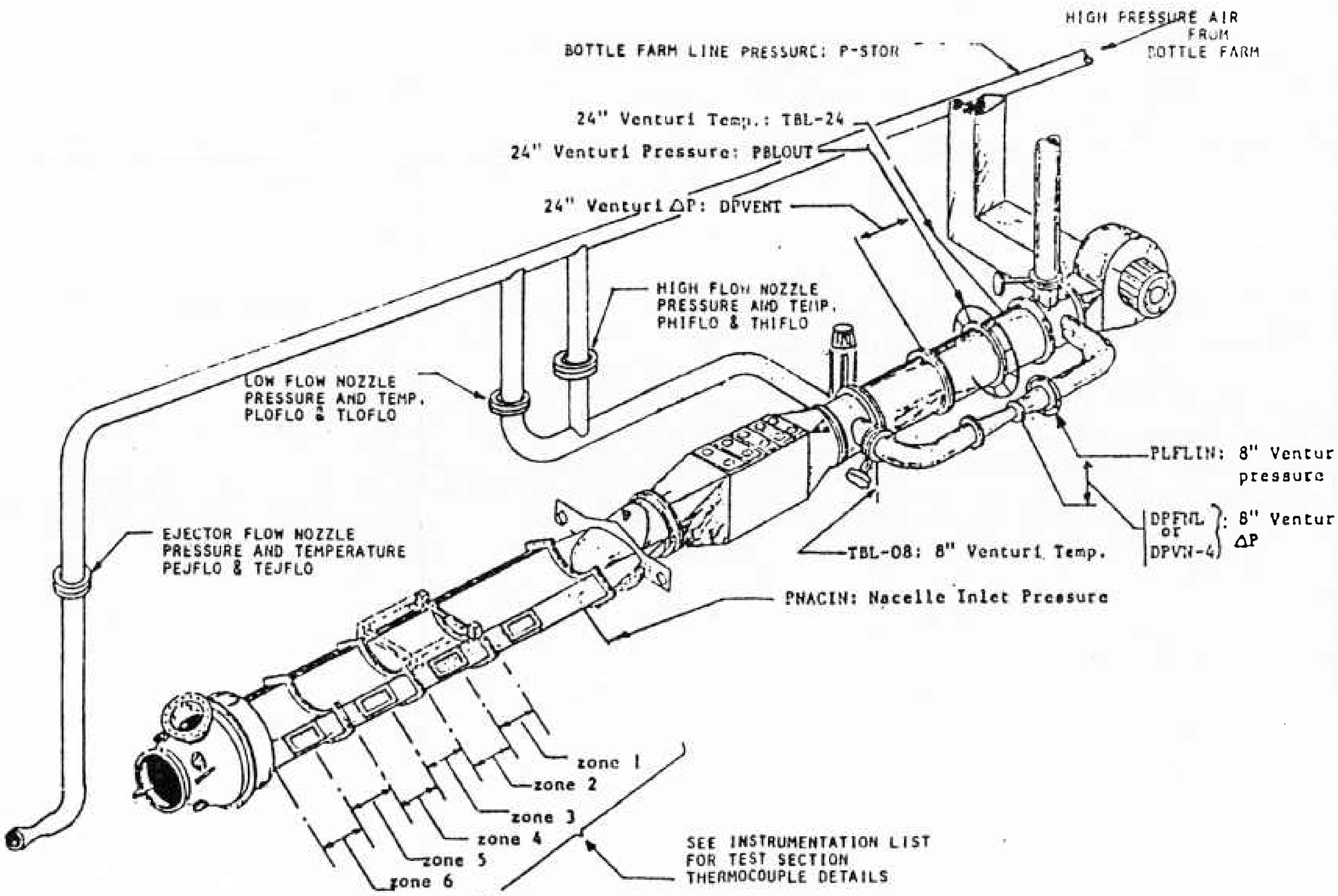



*Figure 4-1. AEN Instrumentation Schematic*

TABLE 4-1.

DETAILS OF BASIC AEN PRESSURE INSTRUMENTATION

| ITEM | SYMBOL | DESCRIPTION | MFG&S/N | RANGE | ACCURACY* |
|---|---|---|---|---|---|
| 1 | PBAROM | Barometric press | S-40737 | 26-32 in.Hg | ±0.25 |
| 2 | PBLOUT | Blower outlet press | S-34212 | 0-50 in. H20 | 0.25 |
| 3 | DPVENT | 24" venturi delta P | S-33659 | 0-60 in. H20 | 0.5 |
| 4 | PLFLIN | 8" venturi inlet press | S-50823 | +1.5 psig | 0.1 |
| 5 | DPVN40 | 8" venturi delta P | M-21784-2 | 0-40 in. H20 | 0.15 |
| 6 | DPVN-4 | 8" venturi delta P | M-21784-1 | 0-4 in. H20 | 0.15 |
| 7 | PNACIN | AEN inlet press | S-34214 | 0-30 psia | 0.25 |
| 8 | P-FUEL | Fuel reservoir press | S-34218 | 0-420 psig | 0.5 |
| 9 | PNZFUL | Fuel nozzle press | S-48291 | 0-500 psig | 0.25 |
| 10 | PEXFAN | Scrubber inlet press | S-27984 | 0-16 in. H20 | 0.25 |
| 11 | PBHNAI | Bleed htr. inlet press | ST-67774 | 0-500 psia | 0.25 |
| 12 | PBH-IN | Bleed air press @ nacelle inlet | ST-67773 | 0-500 psia | 0.25 |
| 13 | PBYNOI | Bleed htr. nozzle inlet pressure | ST-67772 | 0-1000 psia | ±0.25 |
| 14 | PHALON | Halon dump tank press | | | |

*Percent of full scale reading

Manufacturers: S: Sensotec
M: MKS
ST: Setra

TABLE 4-2.

DETAILS OF AEN TEMPERATURE MEASUREMENT

| ITEM | SYMBOL | DESCRIPTION | TYPE | ACCURACY |
|---|---|---|---|---|
| 1 | TENG1A | Engine side skin temp zone 1 | K | ± 4 degrees F. |
| 2 | TENG1B | Engine side skin temp zone 1 | | |
| 3 | TENG2A | Engine side skin temp zone 2 | | |
| 4 | TENG2B | Engine side skin temp zone 2 | | |
| 5 | TENG3A | Engine side skin temp zone 3 | | |
| 6 | TENG3B | Engine side skin temp zone 3 | | |
| 7 | TENG4A | Engine side skin temp zone 4 | | |
| 8 | TENG4B | Engine side skin temp zone 4 | | |
| 9 | TENG5A | Engine side skin temp zone 5 | | |
| 10 | TENG5B | Engine side skin temp zone 5 | | |
| 11 | TENG6A | Engine side skin temp zone 6 | | |
| 12 | TENG6B | Engine side skin temp zone 6 | | |
| 13 | TAIR-1 | Nacelle air temp zone 1 | | |
| 14 | TAIR-2 | Nacelle air temp zone 2 | | |
| 15 | TAIR-3 | Nacelle air temp zone 3 | | |
| 16 | TAIR-4 | Nacelle air temp zone 4 | | |
| 17 | TAIR-5 | Nacelle air temp zone 5 | | |
| 18 | TAIR-6 | Nacelle air temp zone 6 | | |
| 19 | TNAC1A | Nacelle side skin temp zone 1 | | |
| 20 | TNAC1B | Nacelle side skin temp zone 1 | | |
| 21 | TNAC2A | Nacelle side skin temp zone 2 | | |
| 22 | TNAC2B | Nacelle side skin temp zone 2 | | |
| 23 | TNAC3A | Nacelle side skin temp zone 3 | | |
| 24 | TNAC3B | Nacelle side skin temp zone 3 | | |
| 25 | TNAC4A | Nacelle side skin temp zone 4 | | |
| 26 | TNAC4B | Nacelle side skin temp zone 4 | | |
| 27 | TNAC5A | Nacelle side skin temp zone 5 | | |
| 28 | TNAC5B | Nacelle side skin temp zone 5 | | |
| 29 | TNAC6A | Nacelle side skin temp zone 6 | | |
| 30 | TNAC6B | Nacelle side skin temp zone 6 | | |
| 31 | TOUTLG | Nacelle outlet air temp (long) | | |
| 32 | TOUTSH | Nacelle outlet air temp (short) | K | |
| 33 | TCZERO | Analog input system zero offset | RJD | |
| 34 | RTDREF | Reference room temp | T | |
| 35 | TBL-24 | Blower outlet temp | K | |
| 36 | TBL-08 | Low flow venturi temp | | |
| 37 | THTROT | Duct heater outlet temp | | |
| 38 | TNACIN | Nacelle inlet air temp | | |
| 39 | TNACRM | Nacelle room air temp | K | |
| 40 | T-FUEL | Fuel injection reservoir temp | Y | |
| 41 | OATPAD | Pad outside air temp | K | |
| 42 | OAT-RF | Roof outside air temp | | |
| 43 | TSTKLO | Lower exhaust stack temp | | |
| 44 | TSTKUP | Upper exhaust stack temp | | |
| 45 | TBHNAI | Bleed htr. inlet temp | | |
| 46 | TBHOUT | Bleed htr. outlet temp | | |
| 47 | TBHNOI | Bleed air temp at nacelle inlet | K | ± 4 degrees F. |

## 4.2 Agent Concentration Measurement Instrumentation

The quantity of agent required to extinguish a given fire was determined experimentally in the initial fire tests. To measure the actual agent concentration required for extinguishment, these agent release events were repeated with Halon measurement probes installed in the test section connected to six channels of Beckman model LB-2 Medical Gas Analyzers. These units were calibrated to directly measure Halon volumetric concentration in the AEN test section. As shown schematically in Figure 4-2, each of the six channels consisted of a pickup head and a console containing a vacuum pump.

The pickup head contained a dual beam non-dispersive infrared (NDIR) analyzer, a sample cell, a reference cell, a mechanical chopper and a variable capacitance pneumatic detector. A gas sample was drawn through the sample cell and the detector responded to the difference between an IR beam projected through the sample cell and a similar beam projected through the reference cell. The IR absorption of the gas sample determined the gas concentration. Signal conditioning in the pickup head converted the detector output to a voltage signal which was sent to the console.

The console contained the vacuum pump along with a visible flow meter and flow adjustment control and signal conditioning to convert the pickup head preamplifier output voltage to a voltage representative of the actual Halon concentration. A Beckman Halonizer pickup head and console are shown in Figure 4-3.

Response time for these units was largely determined by the lengths and diameters of the pneumatic tubing between the pickup heads and the ends of the probes in the test section. With the probes and connecting tubes used for these tests, the response time was of the order of 150 milliseconds. Accuracy was determined through repeated calibrations with a known 7% "calibration" mixture of Halon 1301 and these units reliably read between 6.8% and 7.2%, even after periods of several days.

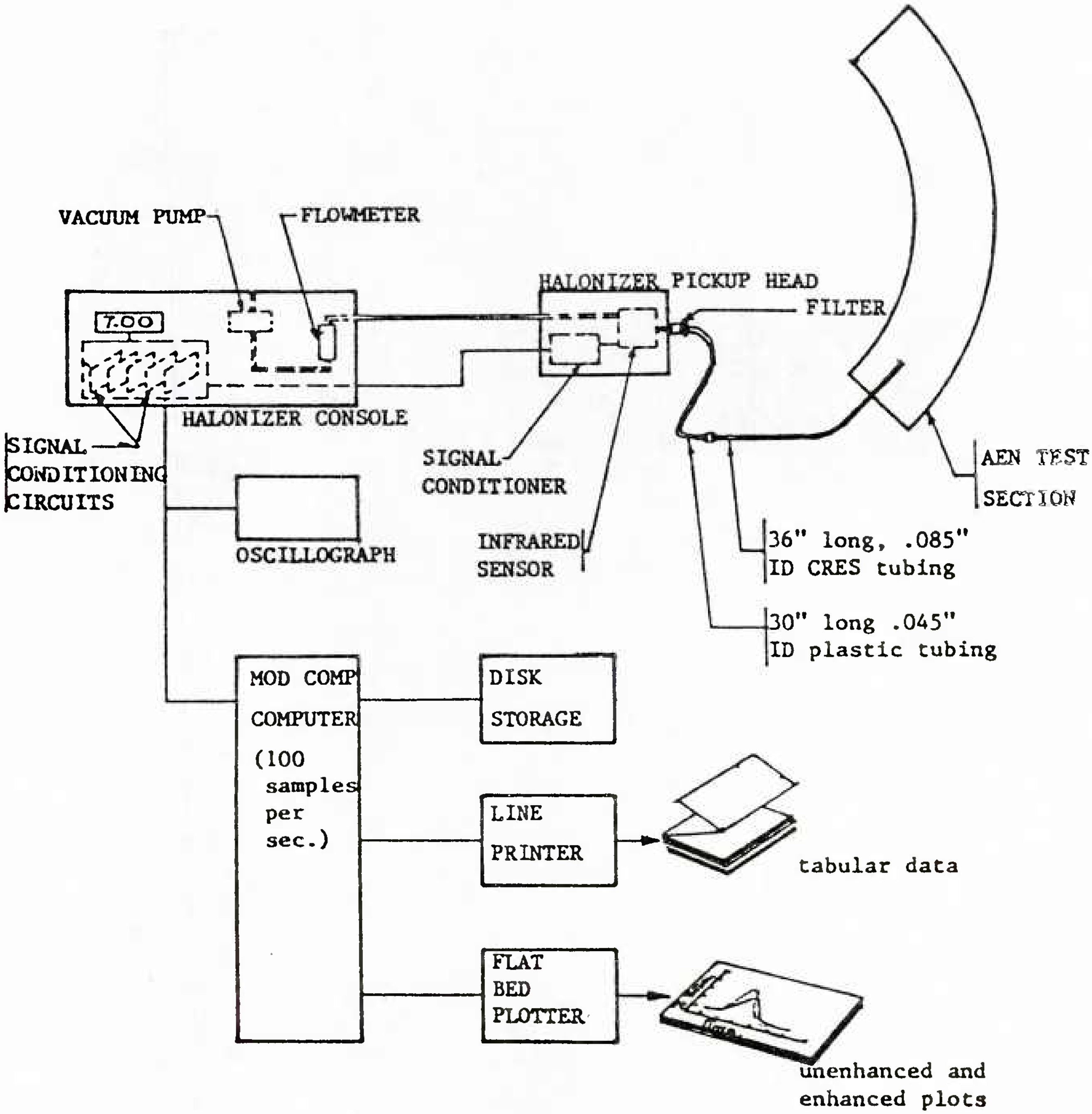



*Figure 4-2. Schematic Diagram of Beckman Halonizer Equipment*

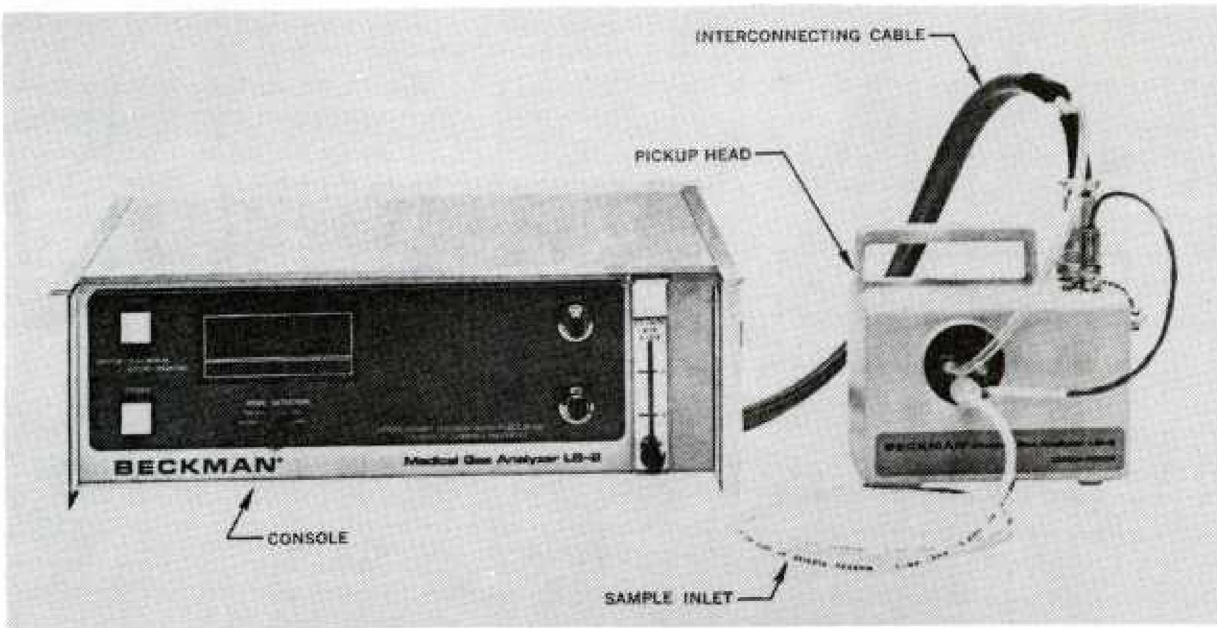



*Figure 4-3. Beckman Halonizer Equipment*

## 4.3 Other AEN Instrumentation

A Concord Model PPC-49 closed circuit TV camera equipped with a zoom lens was mounted on a tilt and pan mechanism on the top of the fuel cart. During fire tests, it was focused on a viewing window in the test cell. The output signal was monitored on a Sony TV monitor on the AEN control panel to allow the test operator to observe fire tests, assure safe conduct of the test and observe the effectiveness of the extinguishant.

A Panasonic model NV-3130 video tape recorder also received the signal from the test cell TV camera. Video tapes were made of most fire tests using this equipment.

## 5.0 DATA ACQUISITION AND REDUCTION

AEN test data consisted of temperatures, pressures and agent concentrations which were measured by sensors in the test cell and sampled, digitized, averaged, and calibrated by the facility computer system. The data included flowrates calculated by the computer, the test run and condition number information used to identify each test event, and the manually recorded information concerning the effectiveness of the various extinguishants. In addition, video tape records were made of the fire tests.

### 5.1 Facility Computer

The AEN facility computer is a 16 bit, general purpose, digital computer for real time multi-programming applications with 64 K RAM memory manufactured by Modular Computer Systems Inc. (ModComp) of Ft. Lauderdale, Florida. The computer is shared with the SAFTE system which is controlled from the same room as the AEN and communicates with the AEN and SAFTE systems through the Input/Output Interface Subsystem (IOIS) located behind the main AEN control panel. The computer receives the following inputs from the AEN system:

- Analog data from the simulator, via the Analog Interface Subsystem (AIS). These include pressures and temperatures.
- Program data from a system disk drive, and measurement data from a data disk drive. These drives are both sequential accessed 2.5 M Byte hard disk memories also manufactured by ModComp.
- Contact sense inputs from the IOIS. These signals allow the computer to sense the state of various switches and relays in the AEN system.
- Operator inputs from the DECWRITER II teletype keyboard and the CRT terminal.

The computer provided the following outputs:

- Analog control outputs to the AEN system, via the IOIS.

- o Contact sense outputs to the AEN system via the IOIS.
- o Test data to the data disk drive (currently Halon concentration data only).
- o Test data to the 132 column ModComp line printer.
- o Halon concentration data to the Tektronix 4662 interactive digital flatbed plotter.
- o Communications with the operator via the teletype and CRT terminals.

Additional information on the ModComp system and detailed information on the system software is available from the ModComp Software User's Manual and the ModComp Software Technical Manual (Ref. 6 and 7).

## 5.2 Acquistion of AEN Test Data

### 5.2.1 Basic AEN Data

Each time the data acquisition switch on the AEN console was operated, the computer acquired AEN digital millivolt data 100 times during a 3.2 second period for all AEN channels. These 100 millivolt values were first averaged and then calibrated using appropriate pressure and thermocouple calibration information to provide engineering unit data. This information then was immediately used to update the AEN display terminals as well as being sent to the line printer, but was not retained by the computer or logged onto the data disk. A schematic diagram of this system is included as Figure 5-1 and a sample of the line printer output of basic AEN data is included as Figure 5-2.

### 5.2.2 Agent Concentration Data

When the test operator opened the Halon dump valve control on the control panel, the computer acquired a 2-second record, at approximately 100 samples per second, for each of the six analog channels of Halon concentration information coming from the Beckman Halonizers. These data were digitized and calibrated using appropriate calibrations for Halon 1202 and Halon 1301. These

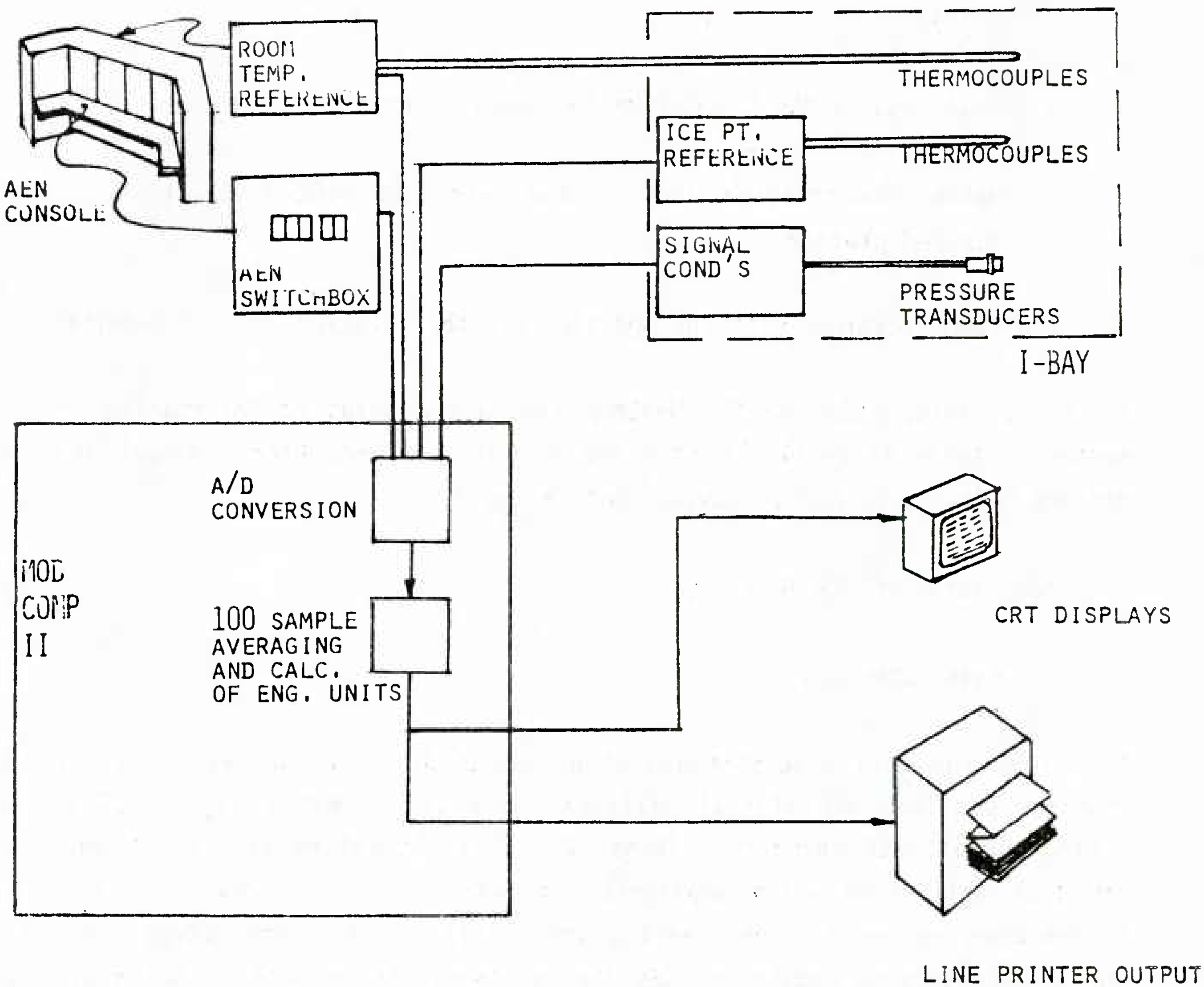



*Figure 5-1. Schematic Diagram of Basic AEN Data Acquisition and Reduction System*

```
AEN TEST 05 PHASES I & II  PHASE II B TESTING - HALON 1301 CONCENTRATIONS
RTIME 13.13.46.17     DATE  2/16/94     AVF  100      RUN  107    COND    15
  VNAC24    WBL-24    TBL-24    DPVENT    PBLOUT    PBAROM    PNACIN    TNACIN
   4.490     0.749    85.854     0.058    15.790    14.359    14.064    94.313
  VNAC-8    WBL-08    TBL-08    DPVN40    DPVN-4    PLFLIN    PNCOUT    TNACRM
  14.772     2.466    94.180    27.527     4.025    15.560    14.064    75.122
  P-FUFL    PNZFUI
  -1.873    -7.269     0.000     0.000     0.000     0.000     0.000     0.000
  TENG1A    TENG1B    TENG2A    TENG2B    TENG3A    TENG3B    TENG4A    TENG4B
  77.779    85.070    76.844    82.380    85.100    76.230    91.597    88.505
  TENG5A    TENG5B    TENG6A    TENG6B    TAIR-1    TAIR-2    TAIR-3    TAIR-4
  89.343    91.397    91.395    92.039    92.393    96.782    99.440   -59.115
  TAIR-5    TAIR-6    TNAC1A    TNAC1B    TNAC2A    TNAC2B    TNAC3A    TNAC3B
  98.718    99.009    98.103    95.026   101.974    93.548    99.751    93.901
  F16- 1    F16--2    F16--3    F16--4    F16--5    F16--6
  74.058    75.433    37.936    71.877    73.714    74.374     0.000     0.000
```

*Figure 5-2. Example of Basic AEN Data*

200 concentration values for each of the six channels were then stored on the data disk for off-line plotting as well as being printed on the line printer. A sample of the line printer output of Halon concentration data is included as Figure 5-3.

Agent concentration data were also recorded using a Honeywell Viscorder. These data provided the test operator with immediate confirmation that the Halonizers were working properly and allowed an independent means of checking the computer reduced data.

## 5.3 AEN Data Reduction

Once the ModComp Computer had calculated engineering unit data for the thermocouples and pressure transducers at the flowmeters in the AEN, these data were used to calculate new airflows and velocities in the test section. The data reduction equations employed are presented in Appendix D. The airflows and velocities displayed on the AEN consoles were updated approximately once every 20 seconds as were the engineering unit data.

## 5.4 AEN Console Display Terminals

The AEN display terminals included a Lear Siegler, Inc. (LSI) CRT unit on the main AEN control console and a Motorola CRT on an equipment rack. These units provided the test operator with engineering unit data and calculated flowrate data which was updated about once every 20 seconds so that flowrates and temperatures could be adjusted with greater precision than would be afforded by the flow rate and temperature information provided by the console digital panel meters. These terminals displayed the AEN data channels in a format similar to that employed on the line printer except that IGG test information was also included.

## 5.5 Manually Logged Agent Performance Information

Of primary importance in these tests was whether the selected charge of Halon agent successfully extinguished the test fire without reignition. This information was obtained by observing the TV monitor in the control room and results were hand logged on the test log sheets along with identification of volume of agent, the dump tank nitrogen pressure, and ventilation airflow conditions.

F.0 MODCOMP SOURCE EDITOR DATE 01/01/01 02:21:41 PAGE 1

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | |
| 2 | HALON :1301 | VALVE OPEN : | 0.010 | | | | | | |
| 3 | CONDTN | RUNNUM | SECNDS | HACON1 | HACON2 | HACON3 | HACON4 | HACON5 | HACON6 |
| 4 | 1 | 155 | 0.01 | 0.180 | -0.003 | 0.015 | -0.012 | 0.152 | 0.173 |
| 5 | 1 | 155 | 0.02 | 0.007 | 0.001 | -0.000 | 0.000 | 0.002 | -0.004 |
| 6 | 1 | 155 | 0.03 | 0.004 | 0.001 | -0.000 | 0.000 | 0.002 | 0.001 |
| 7 | 1 | 155 | 0.04 | 0.004 | 0.001 | -0.000 | 0.000 | 0.003 | -0.015 |
| 8 | 1 | 155 | 0.05 | -0.005 | 0.001 | -0.000 | 0.000 | 0.004 | -0.014 |
| 9 | 1 | 155 | 0.06 | -0.014 | 0.002 | -0.000 | 0.000 | 0.003 | -0.022 |
| 10 | 1 | 155 | 0.07 | -0.009 | 0.001 | -0.000 | 0.000 | 0.002 | -0.012 |
| 11 | 1 | 155 | 0.08 | -0.015 | -0.000 | 0.126 | -0.000 | 0.000 | -0.019 |
| ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ |
| 69 | 1 | 155 | 0.66 | 0.096 | 0.001 | 1.307 | 1.378 | 0.073 | 2.002 |
| 70 | 1 | 155 | 0.67 | 0.168 | 0.000 | 1.871 | 1.888 | 0.121 | 2.593 |
| 71 | 1 | 155 | 0.68 | 0.266 | 0.001 | 2.564 | 2.523 | 0.185 | 3.250 |
| 72 | 1 | 155 | 0.69 | 0.421 | 0.001 | 3.392 | 3.243 | 0.273 | 3.976 |
| 73 | 1 | 155 | 0.70 | 0.635 | 0.002 | 4.322 | 4.059 | 0.385 | 4.771 |
| 74 | 1 | 155 | 0.71 | 0.910 | 0.001 | 5.282 | 4.950 | 0.531 | 5.581 |
| 75 | 1 | 155 | 0.72 | 1.260 | 0.002 | 6.236 | 5.862 | 0.711 | 6.433 |
| 76 | 1 | 155 | 0.73 | 1.665 | 0.002 | 7.106 | 6.744 | 0.918 | 7.231 |
| 77 | 1 | 155 | 0.74 | 2.133 | 0.002 | 7.898 | 7.608 | 1.168 | 8.023 |
| 78 | 1 | 155 | 0.75 | 2.658 | 0.001 | 8.570 | 8.376 | 1.444 | 8.743 |
| 79 | 1 | 155 | 0.76 | 3.225 | 0.002 | 9.128 | 9.072 | 1.747 | 9.343 |
| 80 | 1 | 155 | 0.77 | 3.816 | 0.001 | 9.536 | 9.675 | 2.092 | 9.835 |
| 81 | 1 | 155 | 0.78 | 4.416 | 0.001 | 9.812 | 10.068 | 2.437 | 10.207 |
| ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ |
| 191 | 1 | 155 | 1.88 | 0.007 | 0.001 | 0.130 | 0.163 | 0.002 | -0.001 |
| 192 | 1 | 155 | 1.89 | 0.008 | 0.001 | 0.000 | 0.168 | -0.001 | 0.004 |
| 193 | 1 | 155 | 1.90 | 0.006 | 0.001 | 0.000 | 0.170 | -0.003 | 0.003 |
| 194 | 1 | 155 | 1.91 | 0.006 | 0.001 | 0.000 | 0.160 | -0.005 | 0.010 |
| 195 | 1 | 155 | 1.92 | 0.014 | 0.001 | 0.000 | -0.000 | -0.008 | -0.008 |
| 196 | 1 | 155 | 1.93 | 0.004 | 0.001 | -0.000 | -0.000 | -0.007 | 0.012 |
| 197 | 1 | 155 | 1.94 | 0.007 | 0.001 | 0.000 | -0.000 | -0.008 | 0.009 |
| 198 | 1 | 155 | 1.95 | 0.004 | 0.001 | 0.000 | -0.000 | -0.011 | 0.015 |
| 199 | 1 | 155 | 1.96 | 0.015 | 0.001 | 0.000 | 0.151 | -0.013 | 0.029 |
| 200 | 1 | 155 | 1.97 | 0.015 | 0.001 | 0.126 | -0.000 | -0.164 | 0.020 |
| 201 | 1 | 155 | 1.98 | 0.018 | 0.001 | 0.000 | -0.000 | -0.164 | 0.009 |
| 202 | 1 | 155 | 1.99 | 0.020 | 0.001 | 0.000 | -0.000 | -0.164 | -0.001 |
| 203 | 1 | 155 | 2.00 | 0.016 | 0.001 | 0.000 | 0.154 | -0.164 | -0.011 |

*Figure 5-3. Sample Agent Concentration Line Printer Output*

## 5.6 Video Tape Data

It was intended that a permanent video tape record would be made of all fire tests, using the TV camera and video tape recorder (VTR), to allow re-examination of test events after their occurrence and allow direct comparison of tests run at different times. However, neither the TV nor the TV camera installed in the AEN room performed reliably during much of the testing. When this equipment was operational, video tapes were acquired as part of the fire test data records. Information concerning the particular tape and the location on that tape of the various fire tests which were taped was also recorded on the test log sheets. These tapes and the log sheets may be of some value in understanding the agent performance tests; they are on file as described in Appendix E.

## 5.7 Agent Concentration Data Plotting

The Tektronix flatbed plotter was used to prepare plots of agent concentration versus time. This was an off-line operation and required reloading the ModComp data disks on which a particular set of agent concentration data had been stored. An example of the agent concentration plots is included as Figure 5-4.

## 5.8 Agent Concentration Data Enhancement

The Beckman Halon analysis equipment and the pneumatic tubing connecting it to the sample collection locations in the AEN test section had a response time of about 150 milliseconds. With the close-coupled aircraft type dump system, the rise time to the peak agent concentration measurement was often of the same magnitude causing considerable doubt that these peak concentration measurements were accurate. Experiments were made using a pneumatic system modeling a "square wave" of Halon concentration. From these it was determined that peak concentration measurement could be low by up to 60% for very fast rising concentrations and was often 20% low for normal test data. It was determined, consequently, that some form of computer enhancement of these data was essential.

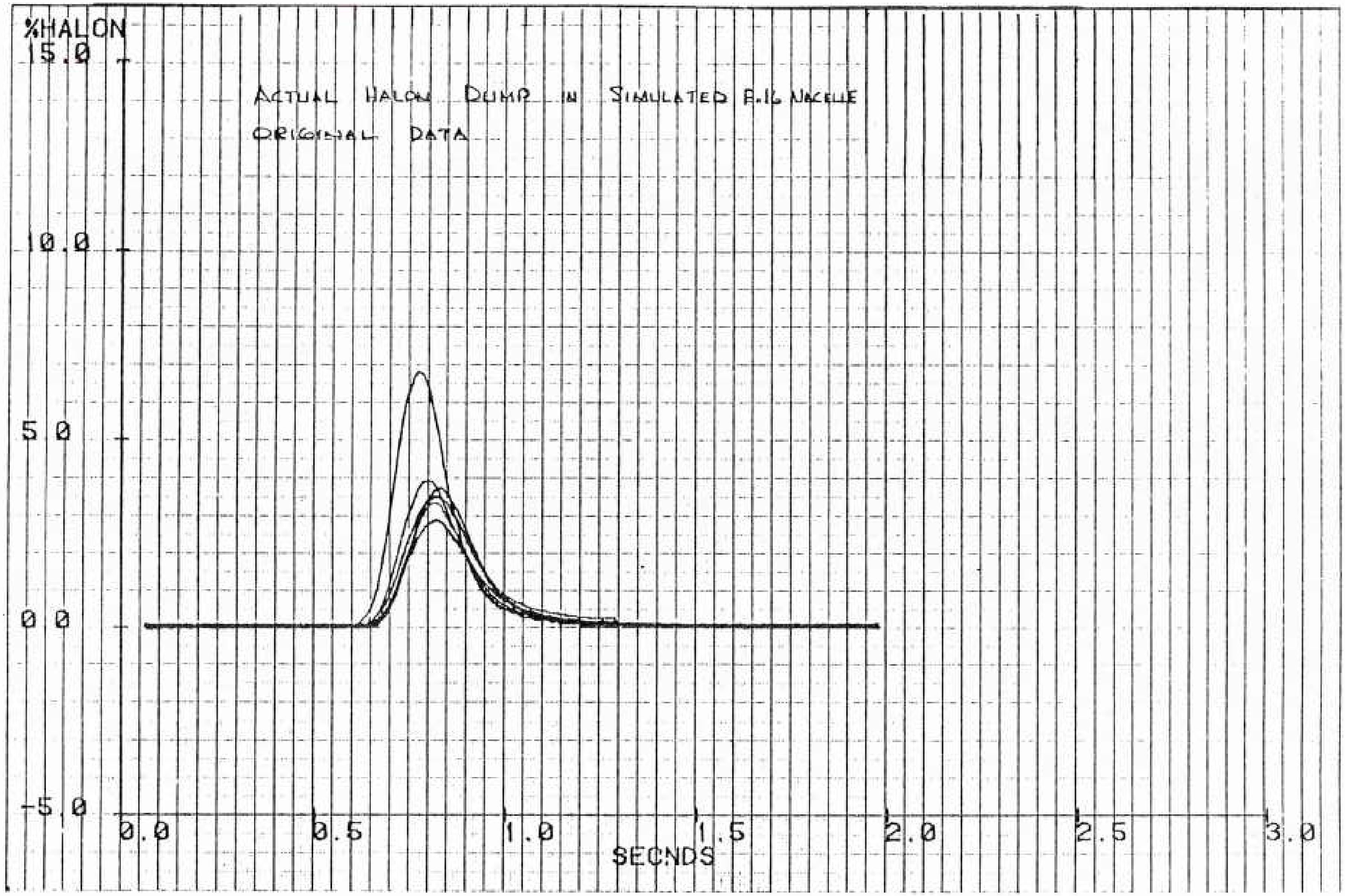



Figure 5-4. Example of Halon Concentration Plots

A long term enhancement technique is being developed which will employ data smoothing and response enhancement software because noise in the concentration data greatly complicate the enhancement problem. An appropriate long term solution may require use of a larger computer.

An interim solution was programmed on the ModComp computer to facilitate short term test conduct and data analysis. This method of data enhancement is documented in Appendix F. It requires some "engineering judgment" to employ this technique because noise in the concentration data can often result in over-shoot in the corrections. This overshoot, as noted in Appendix F, can be identified and the corrected data can be considered to be accurate to within ± 5% of the actual peak concentration.

## 6.0 TEST PROCEDURE

### 6.1 Development of "Standard" Fires in Clean Nacelle

Initial testing with only a flameholder, fuel nozzle and igniter installed in the AEN test section was intended to be used to develop a "standard" fire test to be used throughout this program. This hardware had been developed for the Nitrogen Enriched Atmosphere (NEA) tests which had been conducted earlier in the AEN. (See Appendix B).

#### 6.1.1 Selection of Fuel Flow Rate

The NEA tests (Apendix B) and some of the F-16 electrically heated bleed duct tests (Appendix A), which were conducted in the AEN prior to the current test program, were run using a spray nozzle and JP-4 fuel at 0.13 gpm. It was decided to minimize the variables in these initial tests by using only JP-4 with the same nozzle and flowrate.

#### 6.1.2 Test Repeatability

Initial fire and extinguishment tests were run with the original remote Halon 1301 dump system (see Paragraph 3.1.1). The airflow was varied to determine a minimum ventilation velocity where a given quantity of Halon 1301 would extinguish the fire. Tests were repeated for various Halon injection periods and Halon flowrates. The Halon flowrates were varied by changing the dump system orifice.

The initial tests involved establishing a specific ventilation airflow, at 100$^{0}$F, igniting the 0.13 gpm spray of JP-4, and allowing about 10 seconds of fire stabilization before dumping the Halon. The Halon was released by manually operating the dump valve. The pre-burn interval and the interval that the dump valve was held open were monitored with a stop watch.

Cross-plots from these data should then define the quantities of agent required to extinguish fires at specific ventilation airflow rates. However, inconsistent results were obtained; knockdown flow rates varied widely for seemingly identical tests.

The variations were traced to timing differences from test to test with manual control of agent release. Therefore, an investigation was undertaken to determine event timing sensitivities. The TI programmer was used to control the test sequence with pulse timers to control the duration of the fuel injection, the pre-burn period prior to the agent release, and the Halon injection period.

It was found that the duration of the pre-burn period affected the agent performance, particularly during the first 15 seconds after ignition. Thereafter, a sequence was established where the igniter and the fuel injection valve were manually operated but the TI device controlled the remaining events with its pulse timers. A period of 20 seconds was allowed prior to agent release, the agent release period was set at 1/4, 1/2 or 1 second, and the fuel flow was continued for another 5 seconds following agent release.

Although this did improve the quality of the test data, there was still considerable data scatter. Calibration of the 24-inch venturi was checked using a pitot probe in the test section and a micro-manometer to measure velocity head. Airflow measurement repeatability was found to be about ± 0.25 lbs/sec at 3 lbs/sec where the greatest data scatter had occurred. It was concluded that the airflow measurement was not the cause of the knockdown data anomalies.

A series of tests was conducted to investigate the sensitivity of extinguishant effectiveness to flameholder and test section wall temperature. During these tests, data scatter was discovered to be a strong function of the "wait time" between fire tests. It was found that a temperature cool-off or stabilization period of about 5 minutes, at 8 lbs/sec or higher ventilation airflow, between tests minimized the data scatter problem.

The remaining non-repeatability problems were resolved by defining that three out of four successful extinguishments without reignition established a knockdown point.

### 6.1.3 "Standard" Clean Nacelle Fire Test

The standardized procedure which evolved for fire tests consisted of the following sequence after the initial pre-run checklist was completed:

1. A selected Halon orifice was installed in the Halon dump system and the system was partially filled with Halon 1301. A 350 psig nitrogen back-charge was added to the tank.

2. The VTR counter number, pre-dump Halon load cell reading and intended ventilation flow conditions were manually entered on the run log.

3. The specified ventilation airflow rate was established at a temperature of $100 \pm 2^{o}F$.

4. First the igniter and then the fuel injection valve control were operated manually. The TI programmer then continued fuel injection for the 20 second pre-burn, and the Halon dump interval, which was controlled by opening and closing the air-operated ball valve. Five additional seconds of fuel flow was allowed to ensure that reignition would not occur.

5. Visual observation of the control room TV monitor determined whether the test condition was a successful knockdown.

6. A "cool-off" period of 3 to 5 minutes was allowed before another fire test was begun. Control console temperature gauges allowed the test operator to monitor the cool-off and decide when enough time had been allowed. Another similar test at a higher or lower airflow rate would usually follow employing the same Halon orifice.

As noted in paragraph 3.1.1, the existing Halon dump system used for Halon 1301 testing could not be used for Halon 1202 tests. A system more representative of an actual aircraft installation was developed and used for fire testing with Halon 1202 as well as subsequent testing for Halon 1301.

The new test procedure used a different fill procedure which allowed a series of tests with varying Halon volumes at a single airflow rate (as opposed to varying airflow rates at the same Halon change for the old test procedure). The dump valve open interval remained at 1/2 second even though the dump tank emptied in about 50 milliseconds.

The Halon measurement and fill procedure used with the new system required that a technician go into the test cell between fire tests. Although pressure regulators and plumbing were slightly different for Halon 1202 and Halon 1301 because of differences in their vapor pressure, there was no significant difference in procedure. The refill technique consisted of the following sequence:

1. The sight gauge was filled with the Halon being used. The space above the agent in the gauge was pressurized to slightly above the vapor pressure of the agent to prevent boiling.

2. A valve was opened allowing a measured volume (measurement observed as fluid differential level on sight gauge graduations) to move downward into the dump tank.

3. The remaining volume in the dump tank was back charged with nitrogen to 600 psig.

4. The technician exited the test cell.

5. The fire test was begun as with the previous procedure when an adequate cool-off period had taken place.

## 6.2 Development of "Standard" Fires in F-16 Nacelle Simulator

### 6.2.1 Selection of Fuel Flow Rate

Information from Pratt & Whitney Aircraft indicated that fuel lines on the F-100 engine in the area being simulated in the AEN are normally pressurized to between 14 and 16 psig. To determine the approximate flow rate for a fuel line broken by a HEI burst, a 4-inch segment of an actual fuel line from this part of the engine was tested by connecting it to the AEN fuel cart, pressurizing the cart reservoir to 15 psig and collecting the fuel accumulated as the TI programmer opened the fuel valve for a one minute period. No attempt was made to simulate jagged ends or a particular burst pattern since the worst case fuel leak would come from a clean break with no internal burrs. This test indicated that the maximum leakage rate from a broken line would be about 2.8 GPM.

An actual HEI round would probably produce burns or other constrictions, and leakage from smaller holes in the fuel line. Calculations of the fuel/air ratio indicated that for ventilation flow rates representative of the F-16, a "hotter" fire would exist at a much lower leakage rate than the 2.8 GPM rate stated above. The decision was made to use a 0.52 GPM flow rate for these tests. Subsequent testing confirmed that the 0.52 GPM represented a "worst-case" JP-4 fire for normal F-16 ventilation flowrates.

For hydraulic fluid fires the choices of flow rates was based on a different criterion. Experiments were made with four flow rates (0.12, 0.18, 0.27 and 0.5 GPM). The hydraulic fluids could not be ignited at all at the higher ventilation airflow rates at any flow rate and the fires that were ignited at 1 lb/sec tended to blow out as soon as the ventilation flow rate was increased to 3 or 4 lbs/sec with all but the 0.27 GPM flow rate. Changing the fuel reservoir pressure did not significantly improve the situation. Hence, all the hydraulic fluid fires were run at 0.27 GPM; for fires with ventilation flow rates above 3 lbs/sec ventilation flow rate, it was necessary to ignite the fire at 1 lb/sec before setting the test ventilation rate.

### 6.2.2 "Standard" F-16 Nacelle Simulator Fire Test

All testing with the F-16 nacelle simulator employed the close-coupled Halon dump system. The "standard" fire test was unchanged from that developed with the clean nacelle, as noted in paragraph 6.1.3, except that different fuel flow rates were employed as discussed above. Temperatures within the test section were monitored on the control console DPM's to determine the length cool-off period required. Ventilation airflow rates of 4 to 7 lbs/sec were employed to cool the test section and simulator to about 120$^{o}$F before another test was begun.

## 6.3 Development of "Standard" Agent Concentration Tests

During initial agent concentration tests in the clean nacelle, when the original Halon measurement and dump system was in use, a procedure was used to measure and release the Halon charge which was similar to the procedure followed during the initial fire tests: The desired ventilation airflow conditions were established, the oscillograph chart was started and the agent dump control on the console was employed to activate the TI programmer which opened the air operated dump valve and held it open for a selected period, 1/4, 1/2 or 1 second.

Once the close-coupled dump system was in use, the general procedure established for all the remaining agent release tests was:

1. The ventilation airflow rate and temperature were set to match the fire test conditions being duplicated.

2. The test technician filled the sight gauge, moved a measured charge of agent into the dump tank and back-charged the dump tank with nitrogen to 600 psig. Since there were no fires in this phase of testing, he could remain in the AEN room during tests thereby saving time.

3. The oscillograph chart was started so that a "quick-look" record of the Halon concentrations would be available.

4. The data acquisition switch was used to acquire basic AEN data prior to the agent dump, recording the conditions in the test section.

5. The dump valve was operated causing the TI programmer to:

    a. Start the ModComp acquisition of Halon concentration data at 100 samples per second for a 2-second period.

    b. Open the agent dump valve.

    c. Close the agent dump valve at the end of a pre-set interval (generally 1/2 second).

Due to an eccentricity in the ModComp computer, it was found that 100 sample/second data could only be acquired if the dump valve was operated as the basic AEN data display was being updated on the control console monitor, about once every 20 seconds. Otherwise, timing irregularities resulted.

6. Refilling of the dump tank for the next test could have begun immediately, but it was necessary to wait for all of the Halon concentration data to be printed on the line printer before the next test could be started. This required about 2 minutes.

## 6.4 Combat Damage Testing

Appendix C contains calculations and analysis concerning the effect on F-16 engine compartment ventilation of an HEI "flower" shaped hole in an external surface. The test plan developed for this program considered AEN test simulation capability and scheduling limitations and proposed the engine compartment "worst case" combat damage conditions which could be realistically simulated during this program. Table 6-1 summarizes this information.

### 6.4.1 Combat Damage Outflow Fire Testing

As noted in Table 6-1, the total F-16 engine compartment ventilation airflow would be about 3 lb/sec at maximum afterburning take-off conditions, the only operating condition where outflow of this magnitude was anticipated. Since the F-16 nacelle simulator represented about 1/3 of the engine compartment, a 1 lb/sec. ventilation airflow best simulated the F-16 combat damage environment at this operating condition. Additional data were to be acquired at ventilation airflow rates up to 7 lb/sec to generalize the test results to other aircraft engine compartments.

Test procedures were substantially the same as for earlier F-16 nacelle simulator testing. Test fires included JP-4 at flow rates of 0.13, 0.52 and 1.04 GPM and MIL-H-83282 (hydraulic fluid) at 0.26 GPM. Most of the tests employed Halon 1301 as the extinguishant, but the 0.52 GPM JP-4 fires were repeated using Halon 1202.

The fires were much more difficult to extinguish than during earlier test phases. It was necessary to install a much larger dump tank to hold a sufficient quantity of Halon 1301. The agent measurement and fill operation became somewhat more complicated since a single load of agent would require up to four fillings of the sight gauge. Even with Halon charges comparable to those specified by MIL-E-22285, the fires would frequently appear to be knocked down, but would re-ignite during the 5 seconds of continued fuel injection after the agent release.

The TV monitor in the control room indicated that the fires were much leaner and much hotter than the fires with the same 0.52 GPM JP-4 flowrate during the outflow tests. Portions of the F-16 nacelle simulator appeared to become "white" hot during the 20-second pre-burn period. Several fire tests were conducted where the agent was released after only a 5-second pre-burn period and knockdown was achieved with much smaller Halon charges. It was concluded that the emphasis of the testing should be shifted to determining the time interval following ignition within which the agent must be released to achieve knockdown.

The F-16 nacelle simulator began to show considerable damage as a result of these inflow fire tests. Consequently, an abbreviated test plan was developed to define whether a high speed automated system might be required in an aircraft to survive this type of fire.

The test procedure employed during these runs was unchanged from the earlier inflow tests noted above, except for adjustment of the pre-burn period. Because the larger Halon charges employed for these tests required multiple fillings of the sight gauge and transfer operations into the dump tank, the time periods between tests were longer. Longer periods of cool-off between tests were also generally required and DPM's on the AEN control console were again monitored to determine when sufficient cooling had taken place.

### 6.4.3 Combat Damage Agent Concentration Tests

Because the heated inflow coming from the bleed air heater system probably caused a significant change in the flow patterns in the test section, agent concentration tests were run with the same bleed air conditions as during the fire tests. While there was a concern that the 1200°F flow might damage the plastic tubing leading from the Halon probes to the Beckman Halonizer units, this did not turn out to be a problem. Otherwise, the combat damage outflow and inflow agent concentration test phases were conducted in the same manner as they had been for the initial F-16 nacelle simulator tests.

## 7.0 TEST RESULTS

### 7.1 Baseline Fire Tests

#### 7.1.1 Clean Nacelle Baseline

Initial tests were run with Halon 1301 using the original load cell equipped dump system and 0.13 GPM JP-4 fire. As noted in Section 7.1.1, these data were less accurate than later data acquired with the close-coupled system because of airflow data scatter. However, the data shown in Figure 7-1 illustrate the effect of the duration of the dump on the effectiveness of the agent in extinguishing these fires. Data from later Halon 1202 dumps using the close-coupled system on similar JP-4 fires are included so that the quantity of agent required for knockdown with four durations ranging from 0.05 to 1 second can be compared. The data indicated that the higher the peak agent concentration the more effective the agent was in extinguishing the fire; maintaining a given concentration, for an extended period provided little advantage.

The current military specification for engine compartment fire protection, MIL-E-22285, specifies the quantity of Halon 1301 for fire extinguishment, based on engine compartment ventilation flowrate and volumes. The quantities are determined from:

- $W = 3\,(0.02\,V + 0.25\,Wa)$ — for rough nacelles with high airflow
- $W = 0.05\,V$
- $W = 0.02\,V + 0.25\,Wa$

  (last two) Whichever is greater for smooth nacelles with any airflow, or rough nacelles with low airflow ($Wa < 1$ lb/sec)

Where,

W = weight of Halon 1301 (lbs)
Wa = nacelle airflow (lbs/sec)
V = compartment volume ($Ft^3$)

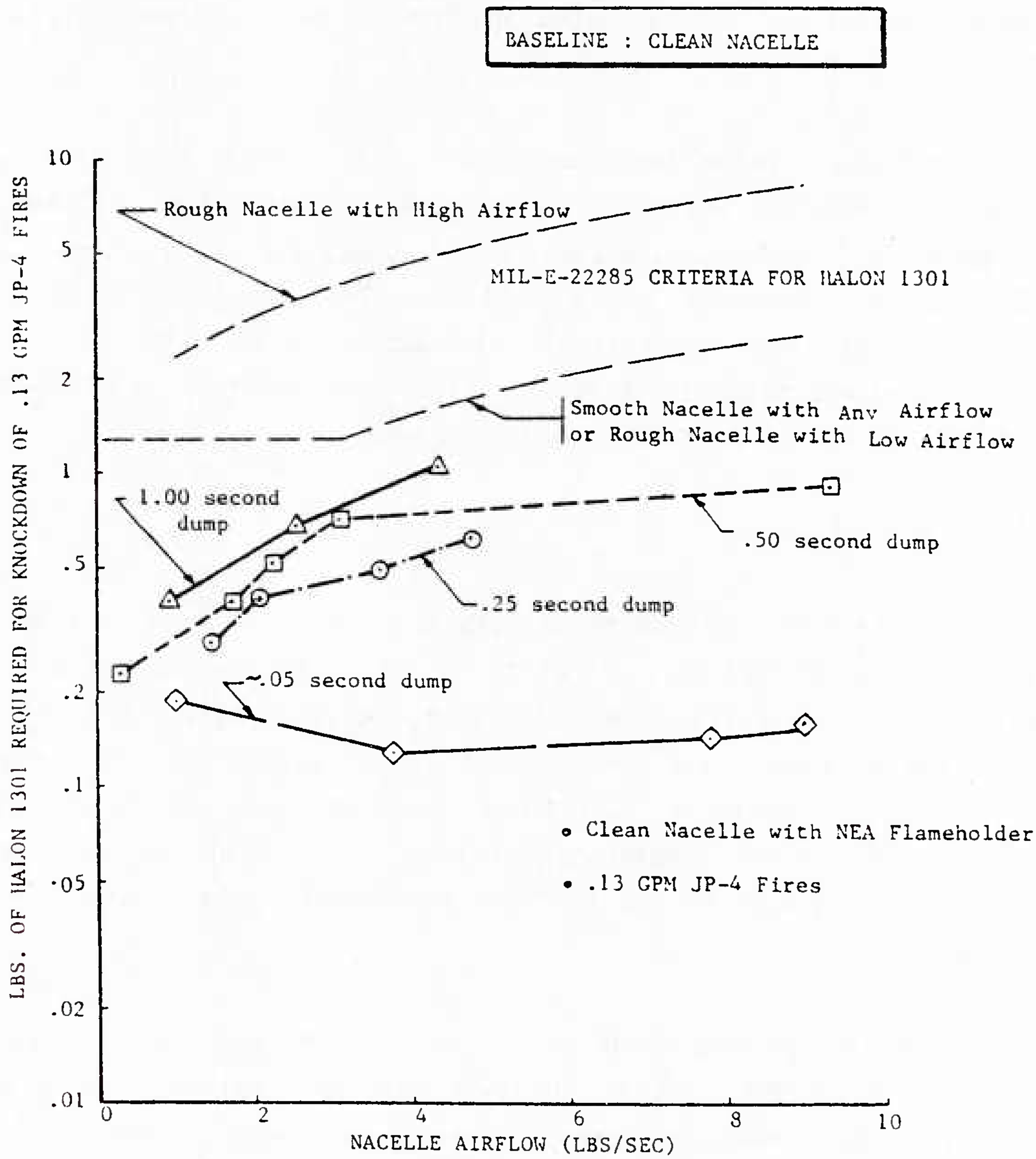



*Figure 7-1. Effect of Dump Duration on Quantity of Halon 1301 Required To Knockdown .13 GPM JP-4 Fires*

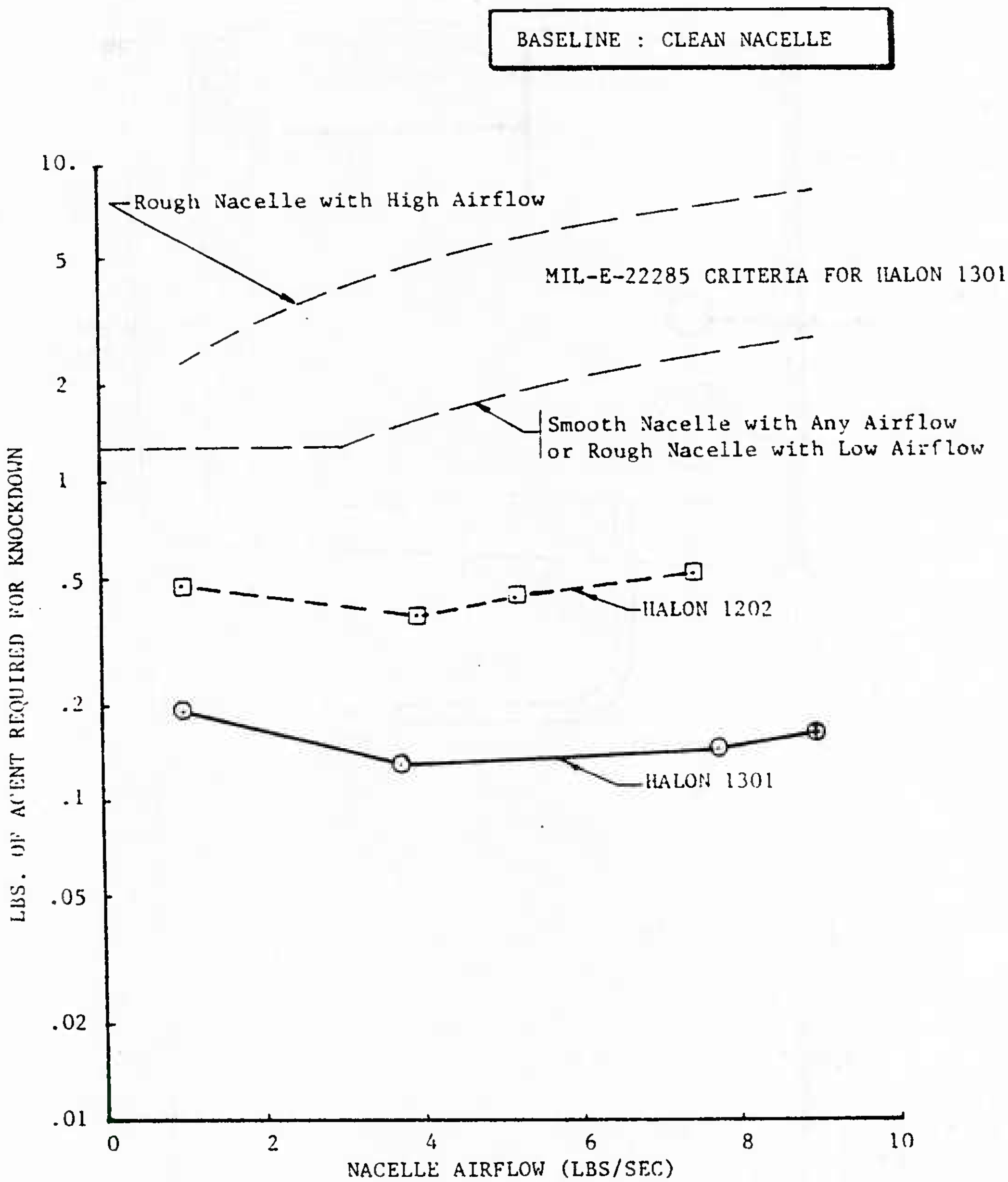
The compartment volume was taken to be the entire AEN cross section (2.44 $Ft^2$) from the piccolo tube Halon discharge manifold to the aft end of the last test section (10.5 ft), a total of 25.6 $Ft^3$. The variation in agent required with ventilation airflow, based on this volume, is shown on Figures 7-1 and 7-2.

Once the close-coupled Halon measurement and dump system were installed, similar data were acquired with both Halon 1202 and Halon 1301. These are shown in Figure 7-2. Somewhat more agent was required for extinguishment when Halon 1202 was used compared to Halon 1301. This was surprising since Reference 7 indicates less agent should be required with Halon 1202. The Halon 1202 required was still substantially less than specified by MIL-E-22285 for these ventilation airflow rates in a smooth nacelle.

### 7.1.2 F-16 Nacelle Simulator

A pitot probe calibration was made of velocities in the F-16 nacelle simulator using a single probe located just aft of the bleed duct near the mid-point of the viewing window. The measured velocity varied greatly as the probe passed behind the bleed duct and into the wake of the simulated aircraft ribs as shown in Figure 7-3. Similar variations would be expected in the same locations within the engine compartment of the F-16. The variations were so large that airflow was used as the ventilation variable in all data analysis rather than velocity.

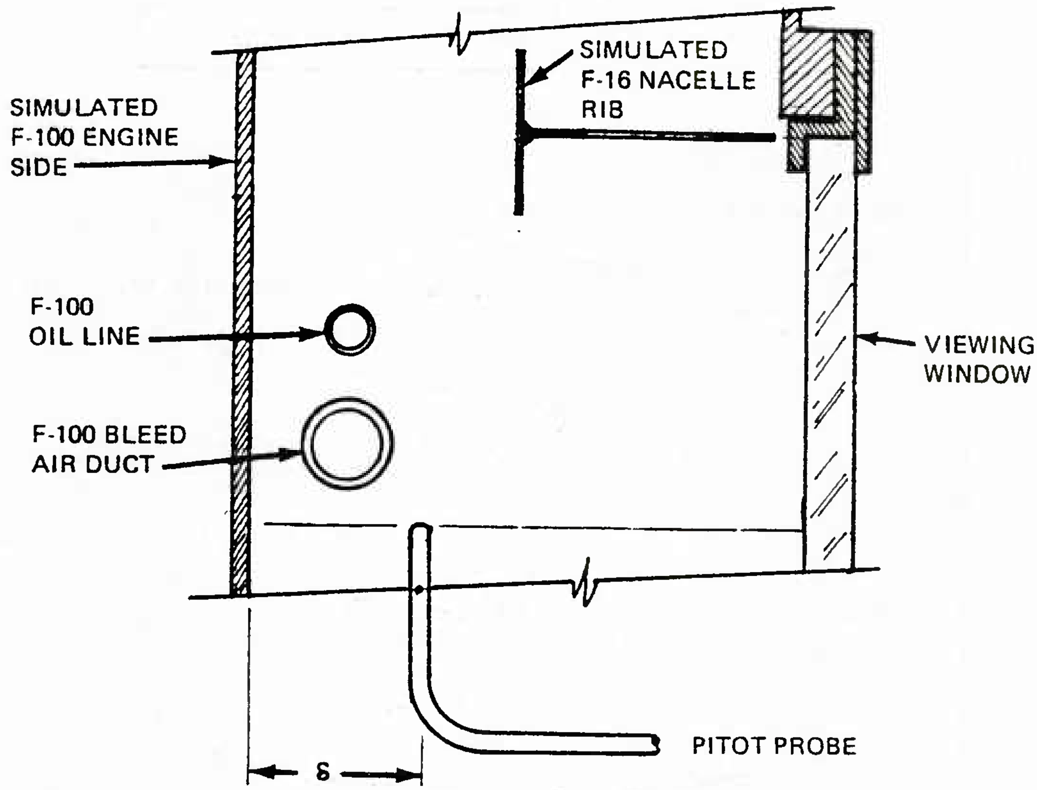
Figure 7-4 shows the quantities of Halon 1301 and Halon 1202 required for knockdown of the 0.13 GPM fires in the F-16 nacelle simulator, where again considerably less than the specification quantity of agent was required. The high local velocities noted earlier probably partially account for this difference. Additional Halon 1301 fire tests were run in the F-16 nacelle simulator using larger flow rate (0.52 GPM vs 0.13 GPM) JP-4 fires and 0.27 GPM hydraulic fluid fires with both MIL-H-5606 and MIL-H-83282. The Halon 1301 required to extinguish the hydraulic fluids and that required for the 0.13 GPM JP-4 fires were comparable (Figure 7-5). Agent quantities required per MIL-E-22285 were again calculated using the equations noted in paragraph 7.1.1. The compartment volume used in these calculations was reduced from 25.6 $Ft^3$ to 21.2 $Ft^3$ based on the intrusion of the simulated glove tank




- NEA Flameholder
- *Piccolo Tube Halon Distribution Manifold
- Short * Halon Dumps Using Close-coupled 600 psig Dump System

*50 to 100 milliseconds

*Figure 7-2. Quantity of Halon 1202 and 1301 Required for Knockdown of 0.13 gpm Fires, Baseline, Clean Nacelle*



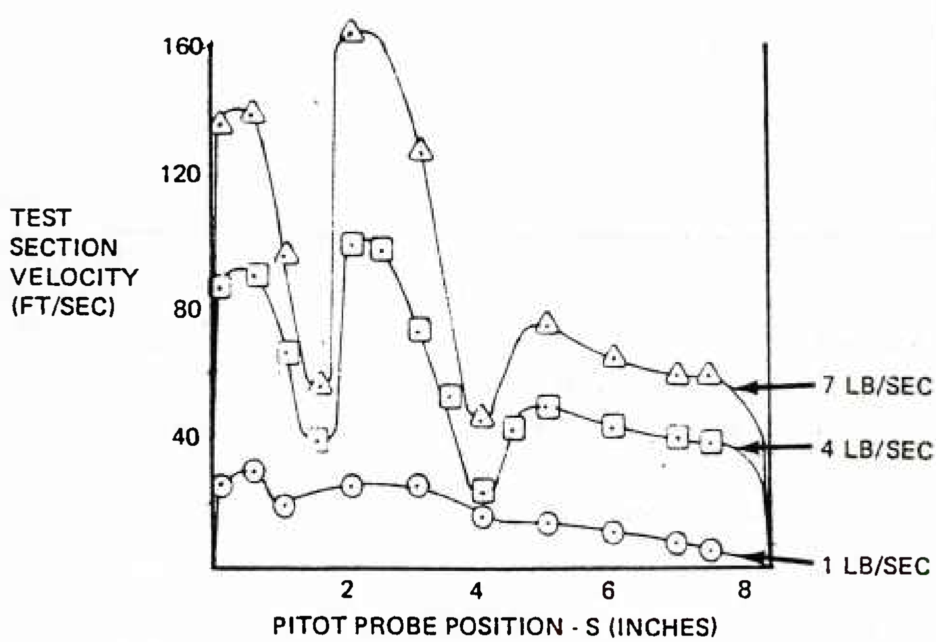
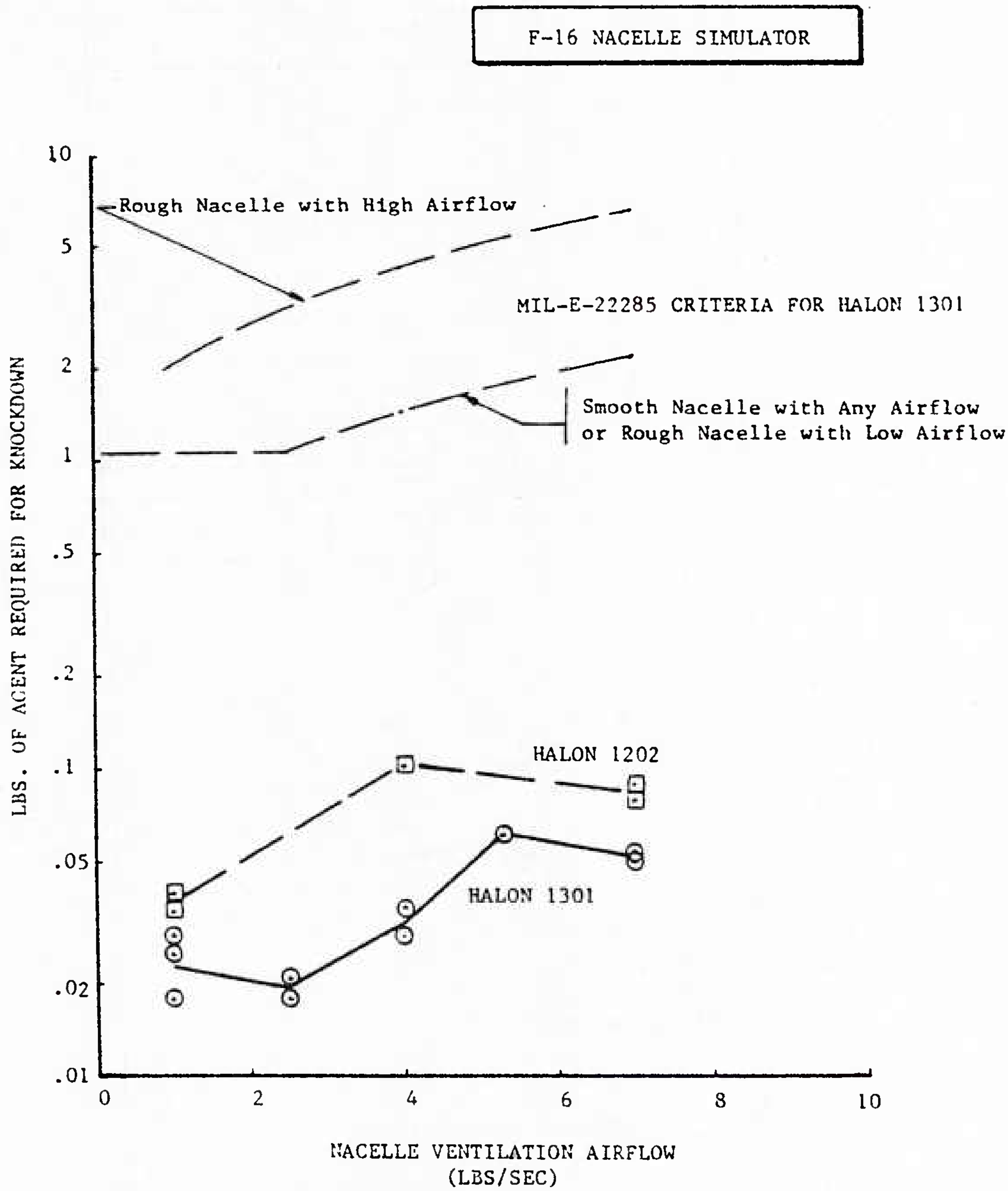



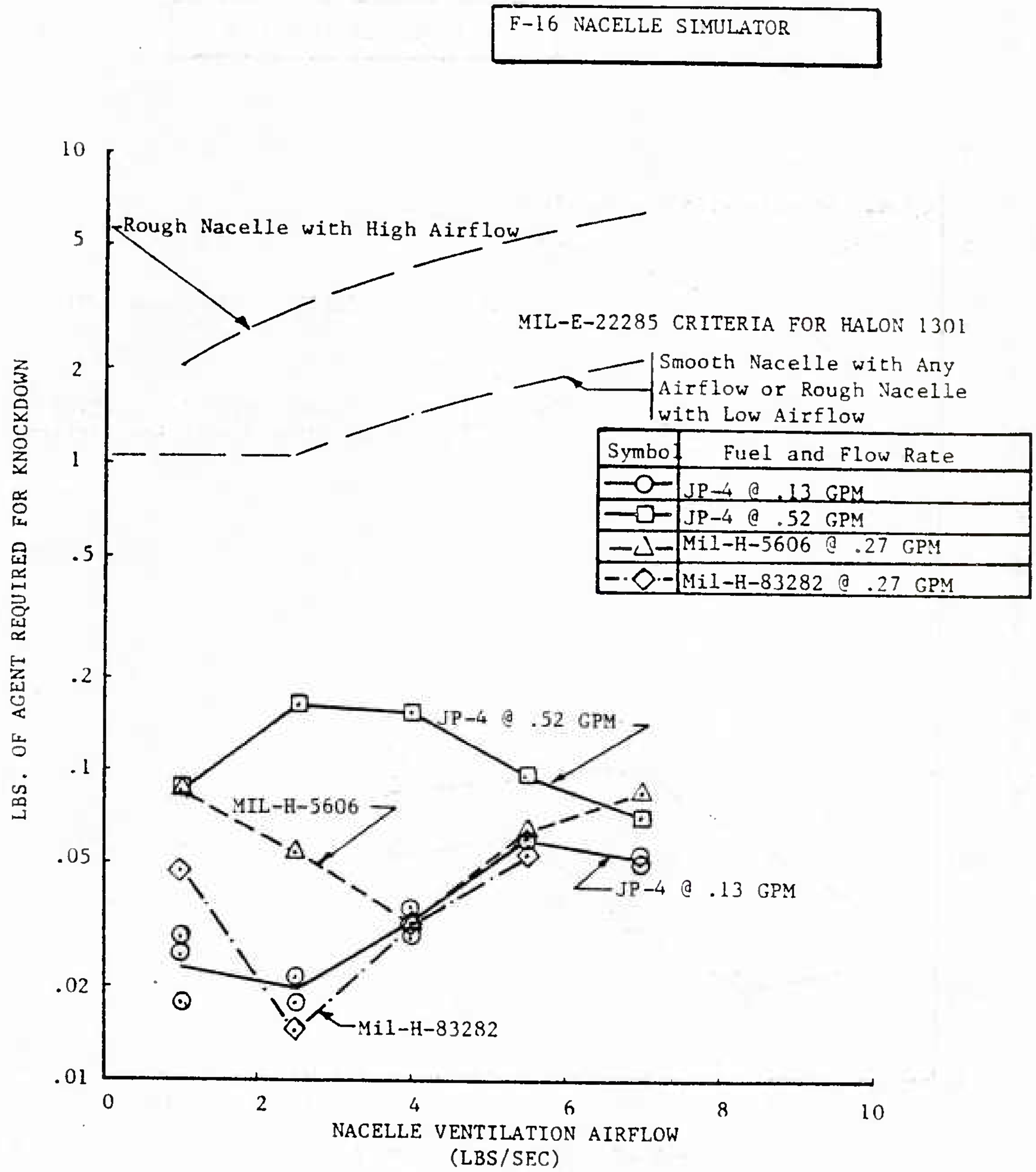

*Figure 7-3. Pitot Probe Traverse of F-16 Nacelle Simulator*




- "Vee-channel" Flameholder in Aircraft Rib Lightening Hole
- Aircraft Type Halon Nozzle
- Short* Halon Dumps using Close-coupled 600 psig Dump System

* 50 to 100 milliseconds

*Figure 7-4. Quantity of Halon 1202 and 1301 Required for Knockdown of 0.13 gpm JP-4 Fires, F-16 Nacelle Simulator*




- "Vee-channel" Flameholder in Aircraft Rib Lightening Hole
- Aircraft-type Halon Nozzle
- Short* Halon Dumps using Close-coupled 600 psig Dump System

  * 50 to 100 milliseconds

*Figure 7-5. Quantity of Halon 1301 Required for Knockdown of 0.13 and 0.52 gpm JP-4 Fires and 0.27 gpm Mil-H-5606 and Mil-H-83282 Fires, F-16 Nacelle Simulator* and engine base plate into the compartment volume. The variation in agent required with ventilation airflow for this compartment volume is shown on Figures 7-4 and 7-5 and all other figures for agent required in the F-16 nacelle simulator. While the higher flow rate JP-4 fire took substantially more Halon 1301 for knockdown at the intermediate flow rates, the amount was still well within that specified by MIL-E-22285.

### 7.1.3 Ultraviolet Fire Detector

While the Ultraviolet (UV) fire detector system remained installed throughout all testing with the F-16 nacelle simulator, its performance had been established at the completion of the first few days of testing. The detector responded with a false warning every time the igniter was operated, but such an igniter would not be present in an actual engine compartment. Since there was much clutter between the detector and igniter and not a clear "line of sight" path, the detector probably responded to reflected light from the igniter. To ensure that the detector was not responding to RF energy, a paper shield was placed over the detector head. Since the detector did not respond to the igniter with this shielding, it was concluded that the detector was responding to reflections of the UV in the igniter spark.

During those fire tests where knockdown was nearly achieved but the fire flashed back up after a few seconds, an opportunity was provided to check the performance of the detector in a more representative situation. In these cases, the fire warning light on the CWU would go off at knockdown and would consistently come back on within a fraction of a second of reignition of the fuel spray. Since it was uncertain whether there was visible flame within the AEN test section immediately following these partial knockdowns, it was not known if the detector always responded to visible flame. Test observers noted that the detector always responded within a fraction of a second to flames that were visible to the observer on the TV monitor.

## 7.2 Agent Concentration Tests

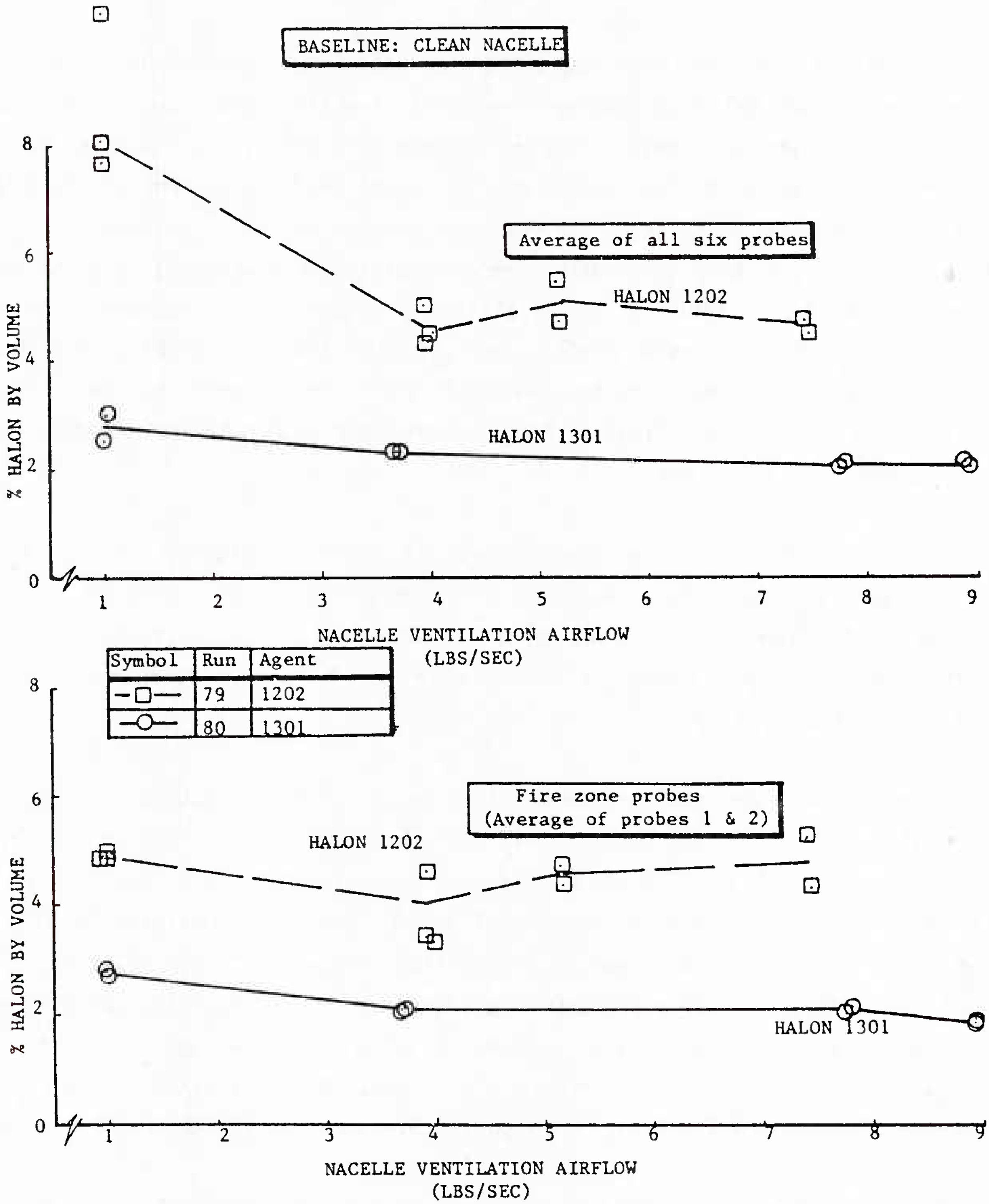
### 7.2.1 Clean Nacelle Baseline

Halon concentration data were obtained for all the combinations of Halon charge and airflow rate identified as knockdown points in the baseline fire tests (Figures 7-2, 7-4 and 7-5). As discussed in Section 5.8, it was necessary to employ a computer enhancement technique to correct for pneumatic response time problems with the Halon probes and the Beckman equipment. The technique used, as discussed in Appendix F, is a temporary approximation being used until a more rigorous technique employing data smoothing, a more complex transfer function, and a larger digital computer is available. Figure 7-6 shows the peak concentration required for knockdown of the baseline 0.13 GPM JP-4 fires in the clean nacelle with the NEA flameholder. Peak concentration data are shown because, as shown in Figure 7-1, a high instantaneous peak value probably has more importance in extinguishment than an extended constant concentration discharge. These data are shown both as an average of all six Halon probes and an average of the two probes which are in the fire zone.

With Halon 1301, there was little difference between the overall average measured concentrations by all six probes and the average of the two probes in the fire zone, implying fairly uniform mixing. A 3% peak concentration would extinguish the 0.13 GPM fires at any ventilation airflow rate. Halon 1202 did not mix as uniformly at the lower ventilation airflow rates, probably due to its greater mass and lower vapor pressure. At the lowest airflow rates it took an 8% average peak concentration of Halon 1202 to achieve a 5% peak concentration in the fire zone. A 5% peak concentration of Halon 1202 in the fire zone would extinguish the 0.13 GPM baseline fires at any ventilation airflow rate.

### 7.2.2 F-16 Nacelle Simulator

Similar data, acquired in the F-16 nacelle simulator are shown in Figure 7-7. For Halon 1301, there is little difference between these and the clean nacelle baseline data, in both cases a 3% peak concentration, both as a nacelle average and as a fire zone probe average, would extinguish the 0.13 GPM JP-4 fires at all nacelle ventilation airflow rates. With Halon 1202, again



Peak Concentrations; Computer enhanced data

*Figure 7-6. Percent Halon 1202 and 1301 Required for Knockdown of 0.13 gpm JP-4 Fires, Baseline, Clean Nacelle* probably due to less uniform mixing, the fire zone and nacelle average concentrations are different; in a specific case, at 4 lbs/sec airflow, nearly a 7% peak concentration was required in the fire zone for extinguishment.

To obtain Halon concentration measurements, tests were conducted in which the airflow rates and Halon discharges repeated the fire test knockdown points, but without injected fuel or fire present. The knockdown Halon 1301 concentration reached during the high flow rate JP-4 fires and the hydraulic fluid fires were all obtained with the same test setup in one series of tests. The six probe average peak Halon concentration measurements are shown in Figure 7-8 as a function of the quantity of agent being dumped. The peak concentration data defines a single straight line for each nacelle ventilation airflow rate, indicating that the computer enhancement technique is effective and that the Halon concentration measurements are accurate and repeatable to within about ± 2% by volume.

A similar plot, for the fire zone probes, is shown on Figure 7-9. While the data scatter is about the same as in Figure 7-8, the lines of constant ventilation airflow rate are not parallel for these probes as they were for the average of all six probes, probably also due to non-uniform mixing of the agent within the nacelle.

The actual peak Halon 1301 concentrations required for knockdown of the four different types of fires in the F-16 nacelle simulator are shown in Figure 7-10. (Figures 7-8 and 7-9 were used as cross-plots to generate Figure 7-10 to present the data in a more meaningful way.) With the exception of the high flowrate JP-4 fires, a 6% peak concentration of Halon 1301 would extinguish any of these fires at any ventilation airflow rate. In the case of the larger 0.52 GPM JP-4 fire, up to 8.5% was required at 2.5 lbs/sec of ventilation airflow. For all of these fires, the peak concentration required for knockdown began to fall off at the highest nacelle ventilation airflow rates.

## 7.3 Combat Damage Outflow Tests

Combat damage outflow tests were run with the simulated HEI "flower" installed in the glove tank wall of the F-16 nacelle simulator. This installation was configured so that 40% of the ventilation airflow was allowed to escape from the engine compartment upstream of the fire zone.

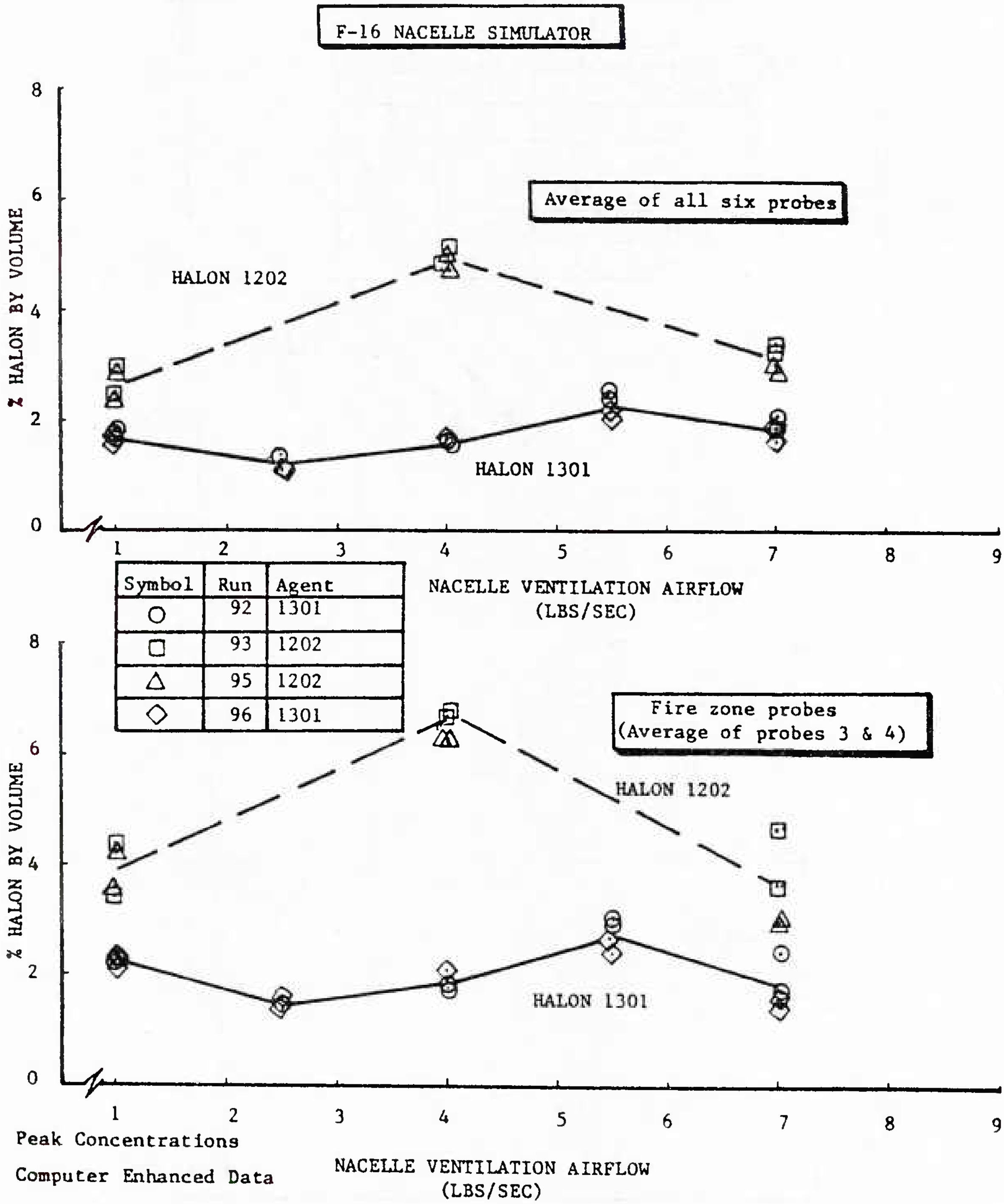



*Figure 7-7. Percent Halon 1202 and 1301 Required for Knockdown of 0.13 gpm JP-4 Fires, F-16 Nacelle Simulator*

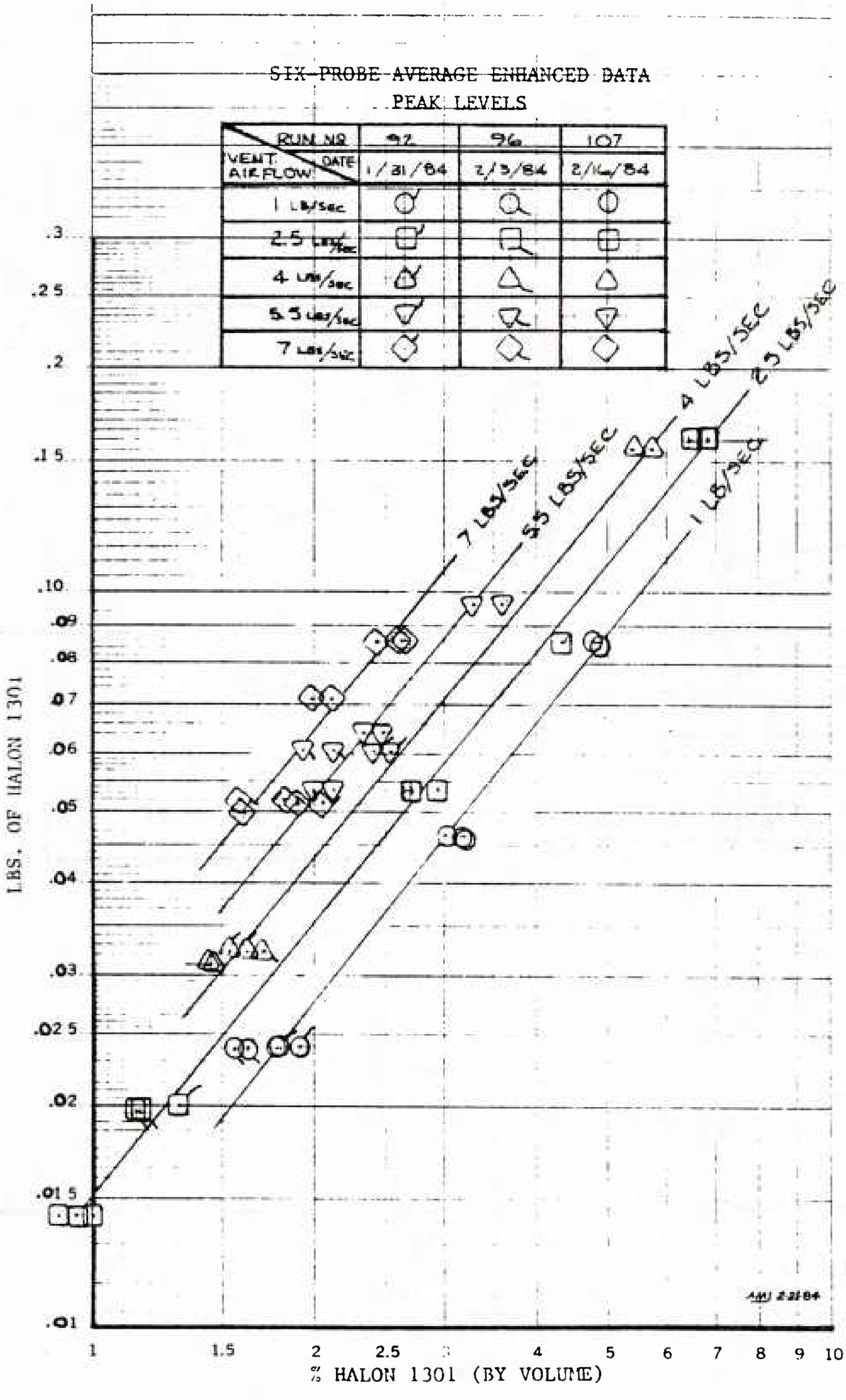



*Figure 7-8. Quantity of Halon 1301 Required to Achieve Specific Concentrations in F-16 Nacelle Simulator*

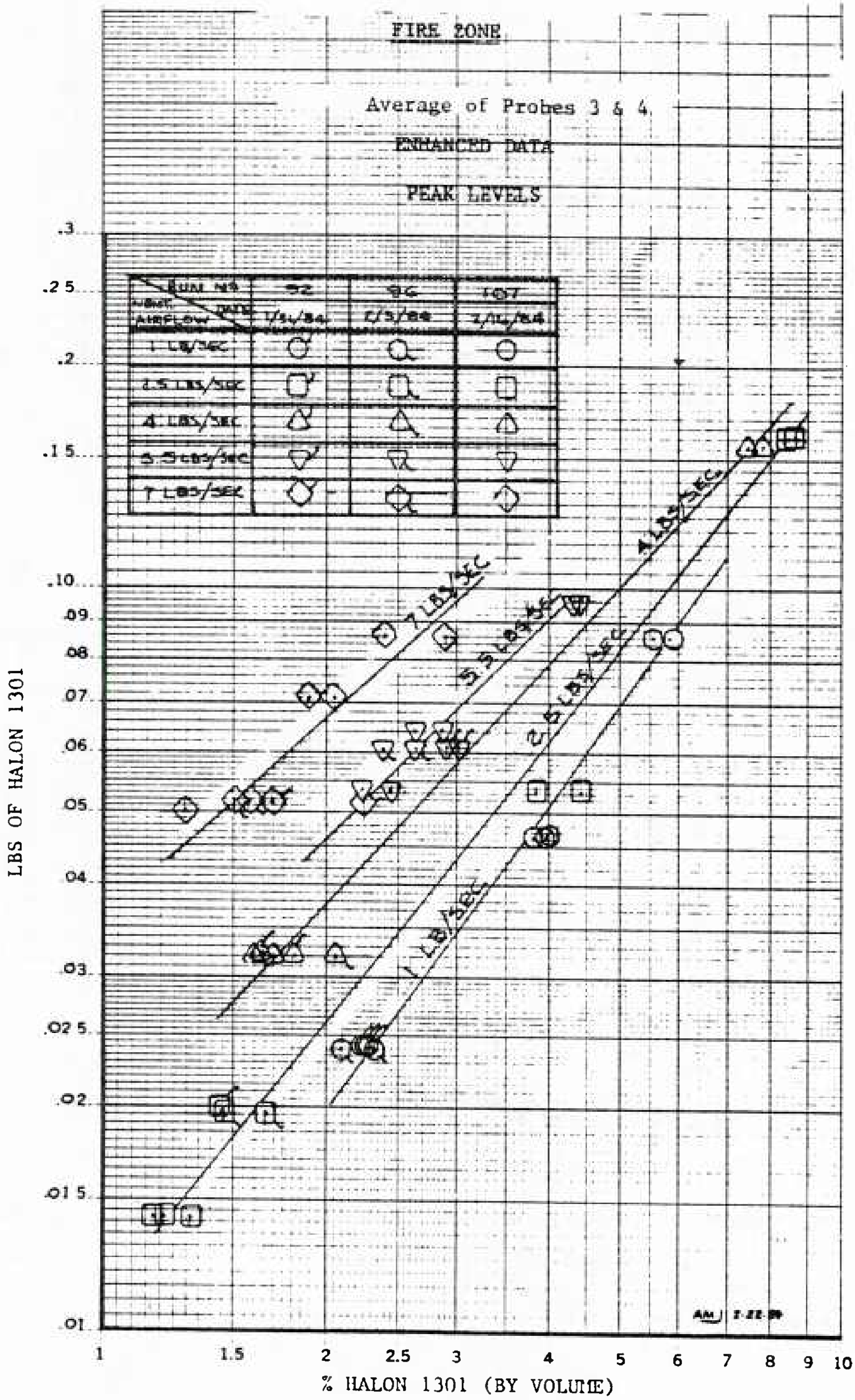



*Figure 7-9. Quantity of Halon 1301 Required to Achieve Specific Concentrations in F-16 Nacelle Simulator Fire Zone*

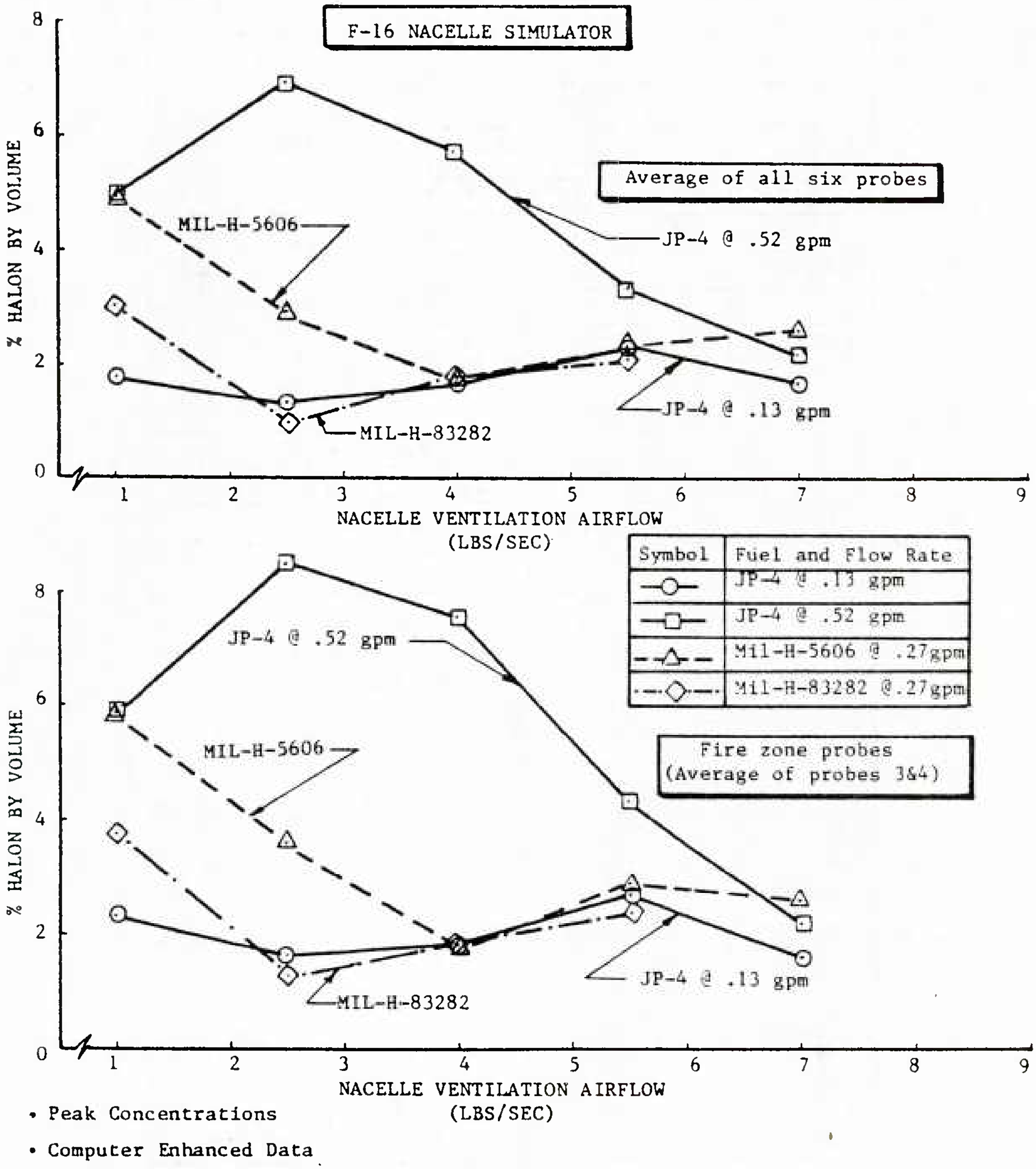


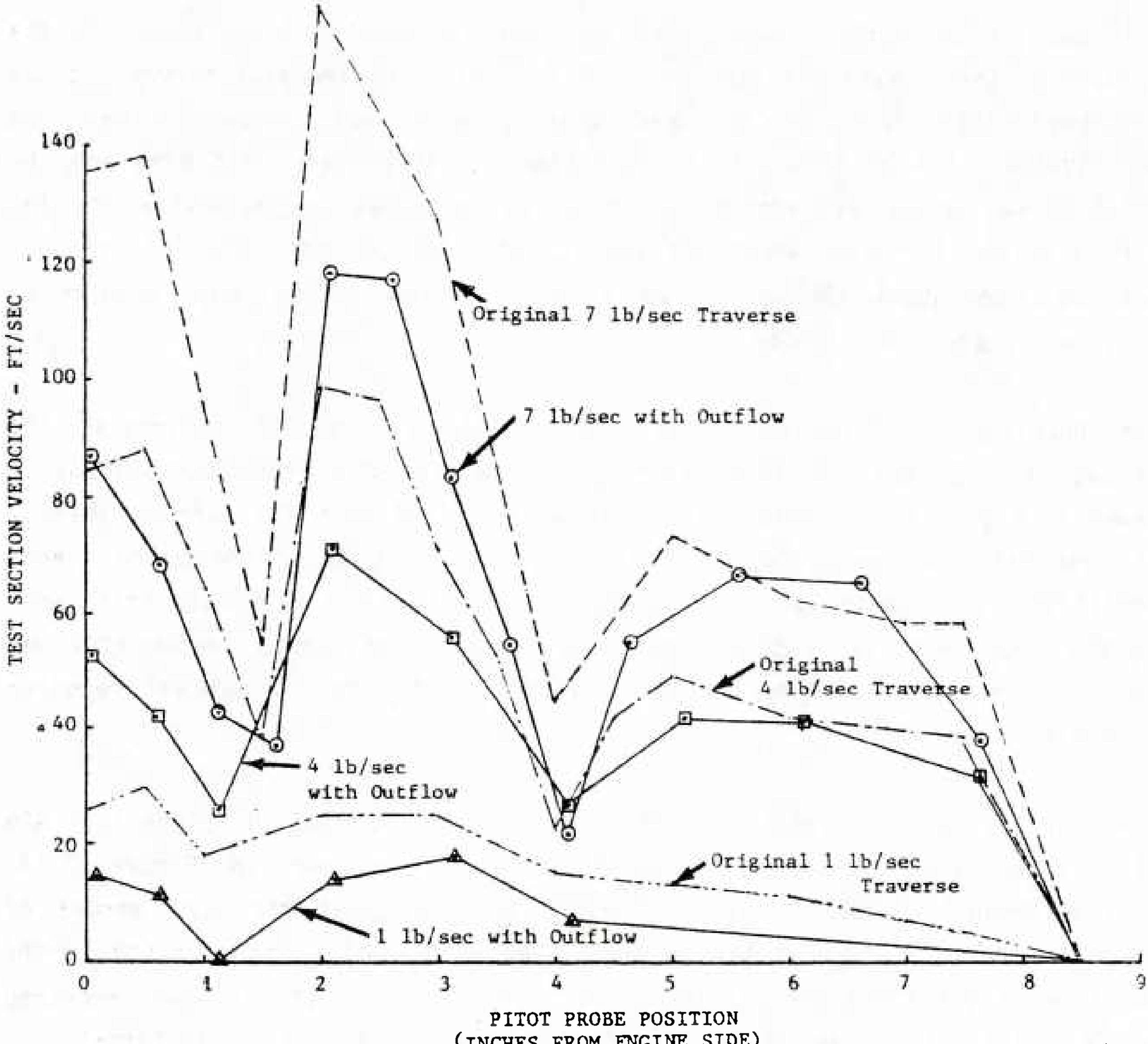

*Figure 7-10. Percent Halon 1301 Required for Knockdown of 0.13 and 0.52 gpm JP-4 Fires and 0.27 gpm Mil-H-5606 and Mil-H-83282 Fires*

A pitot probe survey was conducted at the same location as in the original F-16 nacelle simulator survey using the same equipment. After comparing the results of this survey with the original F-16 nacelle simulator survey, it was concluded that less airflow was entering the HEI "flower" than was anticipated. All baffles were removed from the glove tank exit area and the pitot probe survey was repeated. In this configuration, velocities in the fire zone had decreased about 40% and it was concluded that the HEI "flower" was capturing about 40% of the ventilation airflow as desired. Results of this survey are shown in Figure 7-11.

The quantity of Halon 1202 and Halon 1301 required to extinguish the "standard" 0.52 GPM JP-4 fires in the F-16 nacelle simulator with outflow is shown in Figure 7-12. More Halon 1301 was required with 40% outflow than in the earlier baseline tests; up to twice as much at the highest and lowest ventilation airflow rates. Quantities specified by MIL-E-22285 are still more than 5 times what was actually required for extinguishment. Halon 1202 was not as effective an extinguishant. From 30% to 45% more agent was required than with Halon 1301.

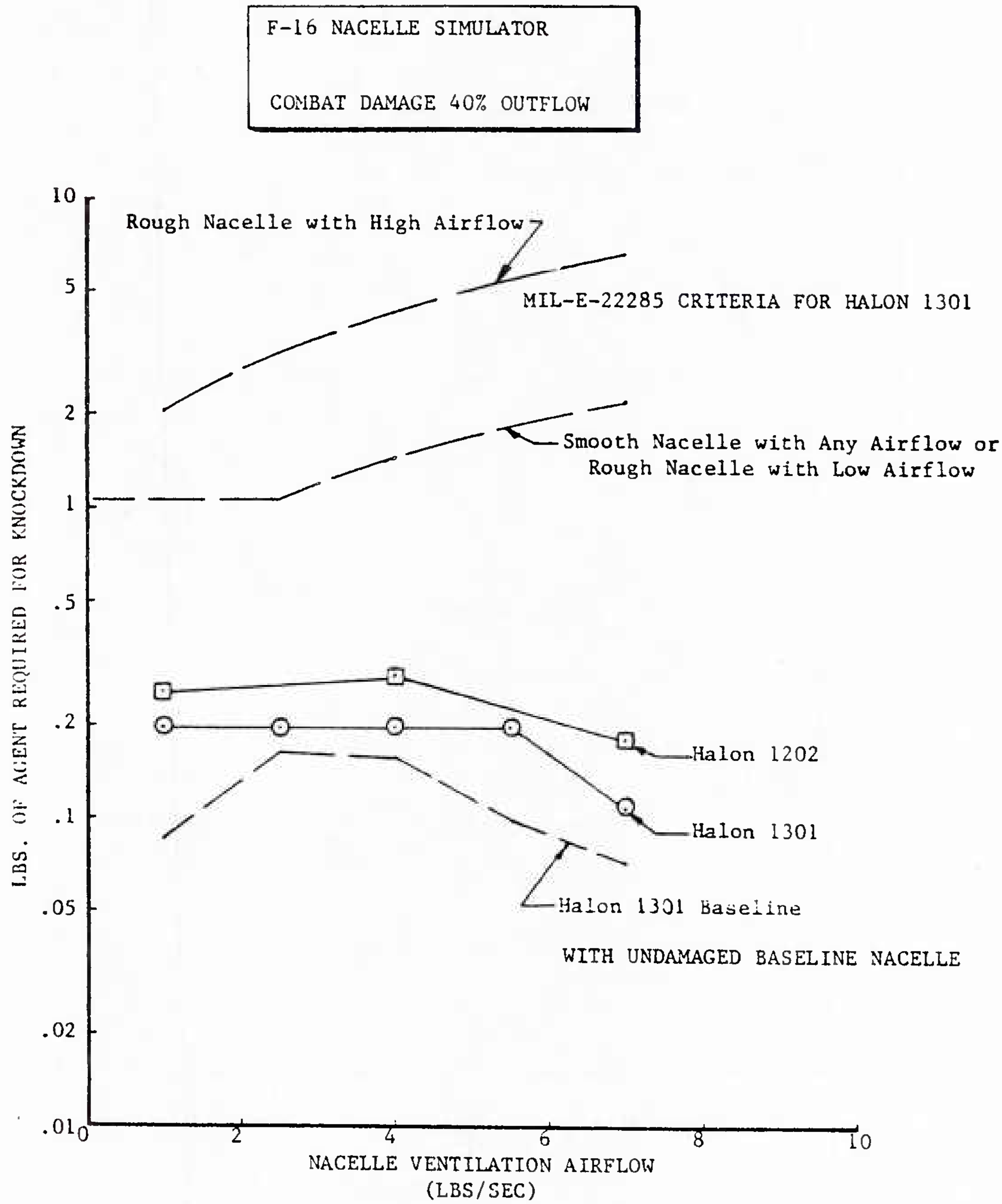
The quantity of Halon 1301 required to extinguish the 0.13, 0.52 and 1.04 GPM JP-4 fires and 0.26 GPM MIL-H-83282 fires is shown in Figure 7-13. Extinguishment of the MIL-H-83282 fires required about the same amount of agent as the 0.13 GPM JP-4 fires. This same relationship was observed in the baseline test without the outflow simulation. The quantity of agent required was substantially below that specified by MIL-E-22285 for all these fires.

With 1 pps ventilation airflow, 1.04 GPM of JP-4 injected and 40% of the ventilation airflow lost into the HEI "flower", the air to fuel-ratio would be only 5.2, substantially lower than the 14.8:1 "ideal". The fire was actually even more fuel rich at this flowrate because not all the remaining ventilation airflow passed through the fire zone. Figure 7-13 illustrates that the fuel/air ratio affects the quantity of agent required for extinguishment. While the 1.04 GPM JP-4 fires required somewhat more agent at the higher ventilation airflow rates than the 0.52 GPM JP-4 fires, they required less at 1 pps, the ventilation flowrate most appropriate to the F-16 engine compartment.




See Figure 8-3 for details of probe position in F-16 Nacelle Simulator

*Figure 7-11. Pitot Traverse of F-16 Nacelle Simulator with HEI "Flower" Installed to Simulate 40% Combat Damage Outflow*




- "Vee-channel" Flameholder in Aircraft Rib Structure
- Aircraft-type Halon Nozzle
- Short (50 to 100 millisecond) Dump using Close-coupled 600 psig Dump System

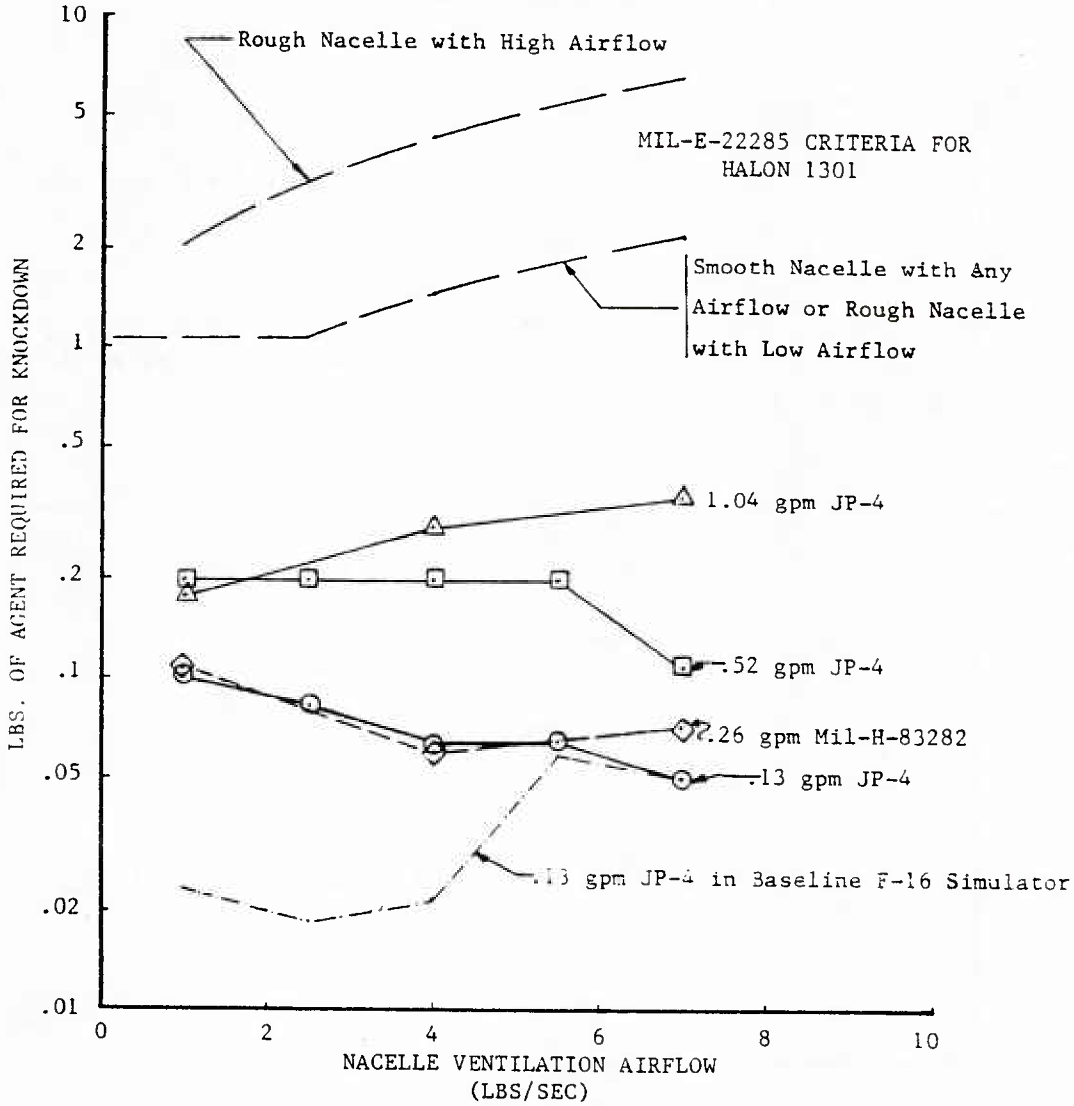
*Figure 7-12. Quantity of Halon 1202 and 1301 Required for Knockdown of 0.52 gpm JP-4 Fires with Simulated Combat Damage Outflow*

QUANTITY OF HALON 1301 REQUIRED FOR KNOCKDOWN

OF .13, .52 AND 1.04 GPM JP-4 FIRES

AND .27 GPM MIL-H-83282 FIRES

F-16 NACELLE SIMULATOR
WITH 40% OUTFLOW
THROUGH HEI "FLOWER"




- "Vee-channel" Flameholder in Aircraft Rib Structure
- Aircraft-type Halon Nozzle
- Short (50 to 100 miliisecond) Dump using Close-coupled 600 psig Dump System

*Figure 7-13. Quantity of Halon 1301 Required for Knockdown of Fires Made with Hydraulic Fluids and JP-4 at Various Flow Rates (Combat Damage Outflow)*

## 7.4 Combat Damage Outflow Agent Concentration Tests

The relationship between the quantity of agent discharged into the simulated engine compartment and the peak agent concentration obtained within the compartment is shown in Figure 7-14 for Halon 1301. These data were taken from computer enhanced plots of the Beckman Halonizer data. They are arranged such that the average concentration measured by all six Halonizer probes and the average concentration in the fire zone (average of probes 3 and 4) are both shown on the same figure.

Figure 7-15 illustrates the peak concentration of Halon 1202 and Halon 1301 required to extinguish the 0.13 GPM JP-4 fires. The Halon 1202 concentration data shown for the six probe average (Figure 7-15a) exhibit scatter of about 25% of the reading, approximately twice the scatter band of the Halon 1301 concentration data shown on Figure 7-14. In the fire zone (Figure 7-15b), the Halon 1202 concentration data scatters by more than 50% of the concentration reading. It is theorized that the lower vapor pressure of Halon 1202 was somehow resulting in inconsistent mixing of the agent with the ventilation airflow.

Figure 7-15 also illustrates that a 6% peak concentration of Halon 1301, as an average of all six probes, would extinguish the 0.52 GPM JP-4 fires as specified in MIL-E-22285. This specification also requires a 1/2-second duration of this concentration, a condition which was not met in these tests and did not seem to be required either for initial extinguishment or to prevent reignition. The peak concentration required in the fire zone was slightly higher than the six probe average, but was not significantly in excess of the 6% specification.

For Halon 1202, Figure 7-15 indicates that a surprisingly high concentration was required to extinguish these fires, nearly 20% by volume at the lowest airflow rates. For both Halon 1202 and 1301, the agent quantity required for extinguishment decreased as the ventilation airflow rate increased. The quantity of agent required for extinguishment had become sufficiently small at 7 pps, for all but the 1.04 GPM JP-4 fire, that it appears that these fires could not be ignited or would be blown out without agent at a slightly higher ventilation airflow rate. Since the 7 pps rate was the maximum that was available with the F-16 nacelle simulator, this assumption could not be confirmed in actual tests.

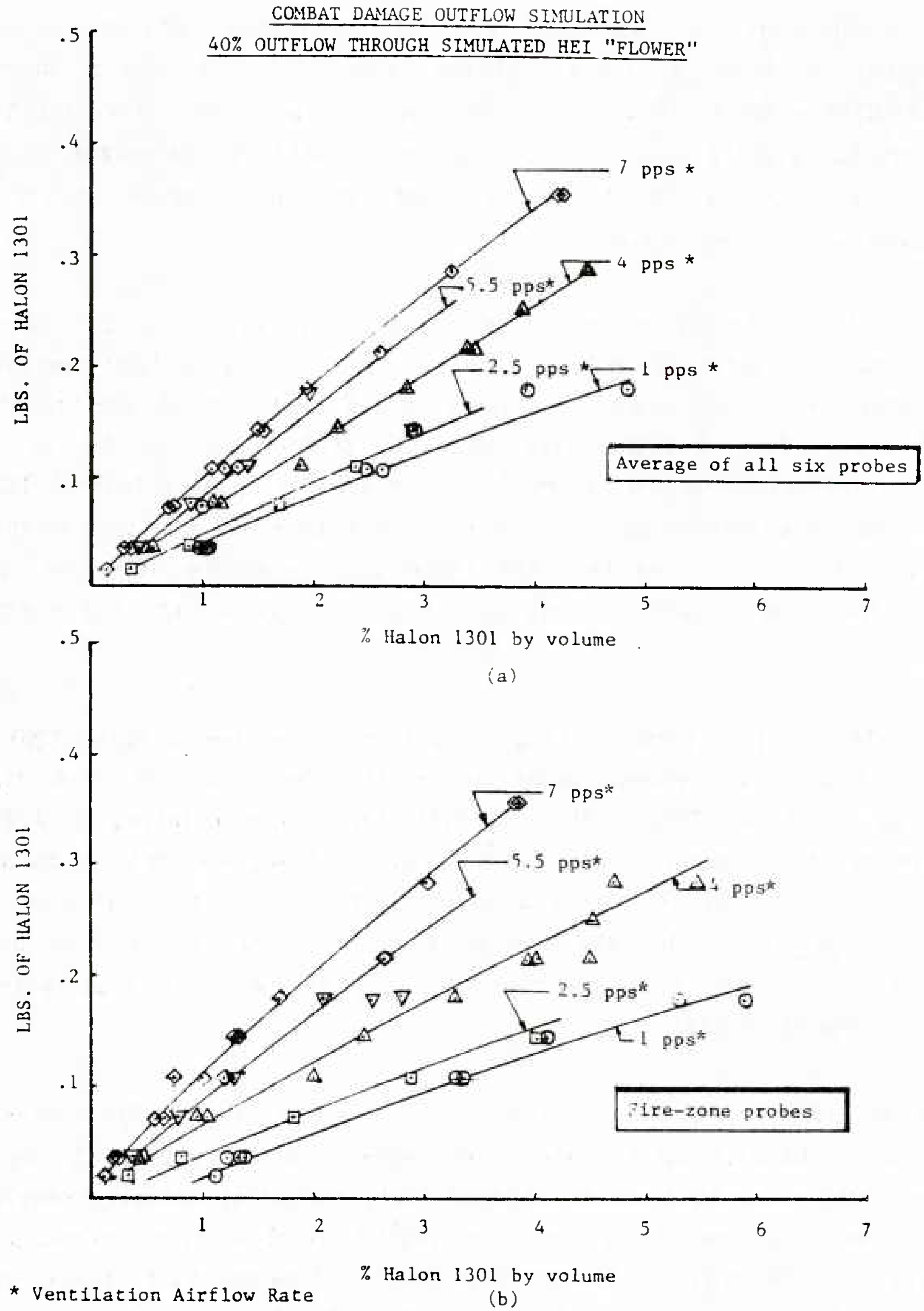



*Figure 7-14. Quantity of Halon 1301 Required to Achieve Specific Concentrations in F-16 Nacelle Simulator (Combat Damage Outflow)*

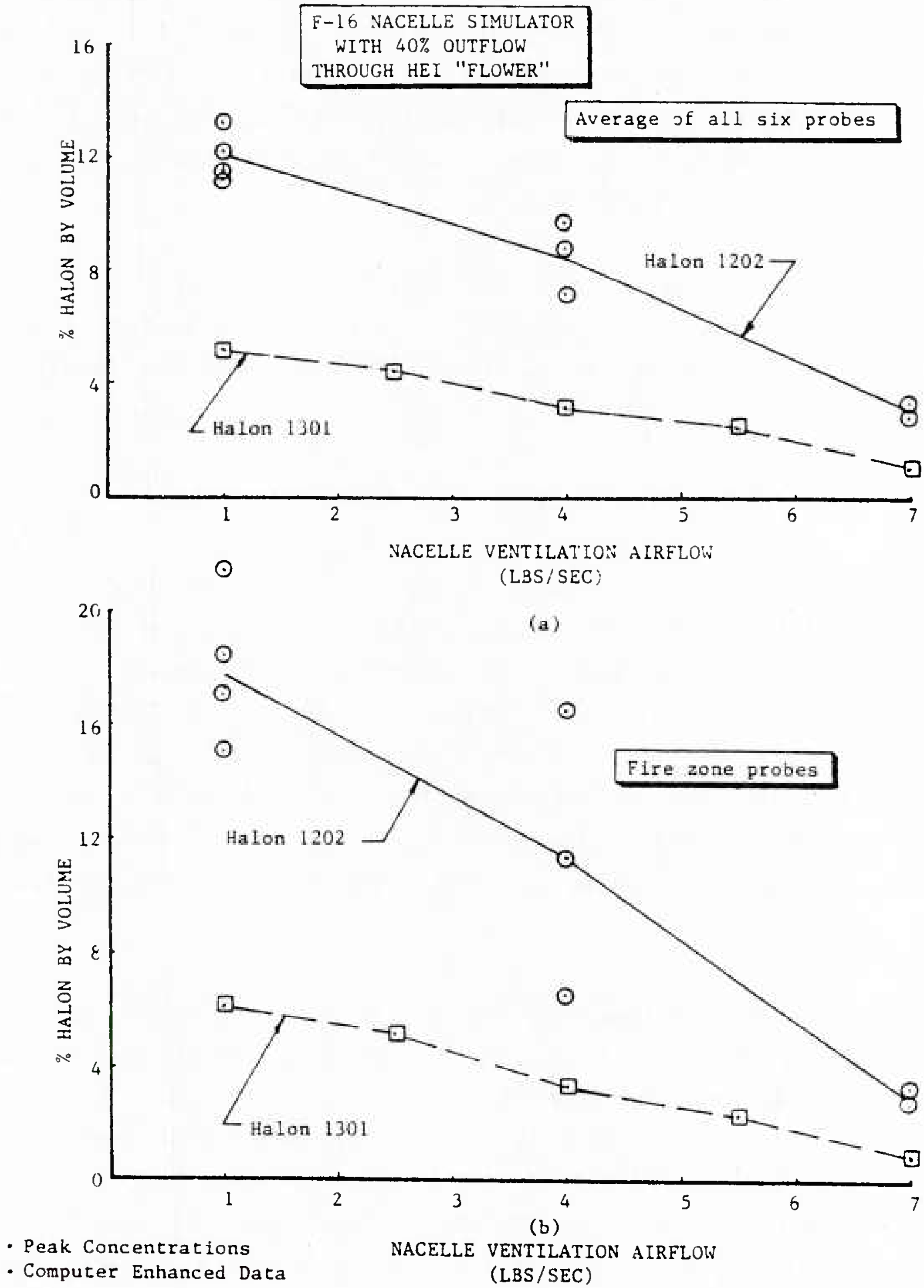



*Figure 7-15. Percent Halon 1202 and 1301 Required for Knockdown of 0.52 gpm JP-4 Fires (Combat Damage Outflow)*

This same trend is also shown in Figure 7-16 for Halon 1301 applied to the 3 types of JP-4 fires and to the MIL-H-83282 fires. Only the 1.04 GPM JP-4 fire did not take a significantly lower agent concentration for extinguishment at the higher airflow rates. Again, a fuel/air ratio effect is probably illustrated here; at 7 pps, with 40% of the ventilation airflow going out through the HEI "flower", a near optimum 14.5 air to fuel ratio would be provided if 40% of the remaining nacelle ventilation airflow reached the fire zone and was available for combustion.

Note that a 6% peak concentration of Halon 1301 was also sufficient to extinguish all the fires tested at ventilation airflow rates from 1 to 7 pps as specified by MIL-E-22285 but at durations less than the specified 1/2 second.

## 7.5 Combat Damage Inflow Fire Tests

Evaluation of the effect of combat damage caused inflow into the engine compartment consisted of introducing an additional 1 pound per second of air from the bleed air heater system at temperatures of ambient, 424$^{o}$F. and 1200$^{o}$F. These were to simulate inflows, respectively, through an HEI "flower" in the outer skin, from a fan blade perforation, and from a damaged bleed air duct. The flow was introduced into the F-16 nacelle simulator at the forward end of the F-100 engine right-side bleed duct which was clamped to produce a gap of about 1 inch between the bleed duct and the augmentor fuel pump.

With ambient temperature inflow air, substantially more agent was required for knockdown of these fires than those with the undamaged F-16 nacelle simulator or with outflow. As shown in Figure 7-17, the quantity of Halon 1301 required at lower ventilation flow rates (1 and 4 pps) was about equal to that specified by MIL-E-22285. At higher ventilation flowrates, the additional air introduced seemed to make the fire too lean to be stable. It was necessary to drop the ventilation flowrate to 1 pps to ignite the fire and when the flow was "snapped" to 7 pps it would go out by itself. At intermediate flowrates, between 4 and 7 pps, the fires would not self extinguish when the flow controller was "snapped" to the selected value, but nitrogen alone in the dump tank would generally extinguish them. Since the flowrates between 1 and 4 pps

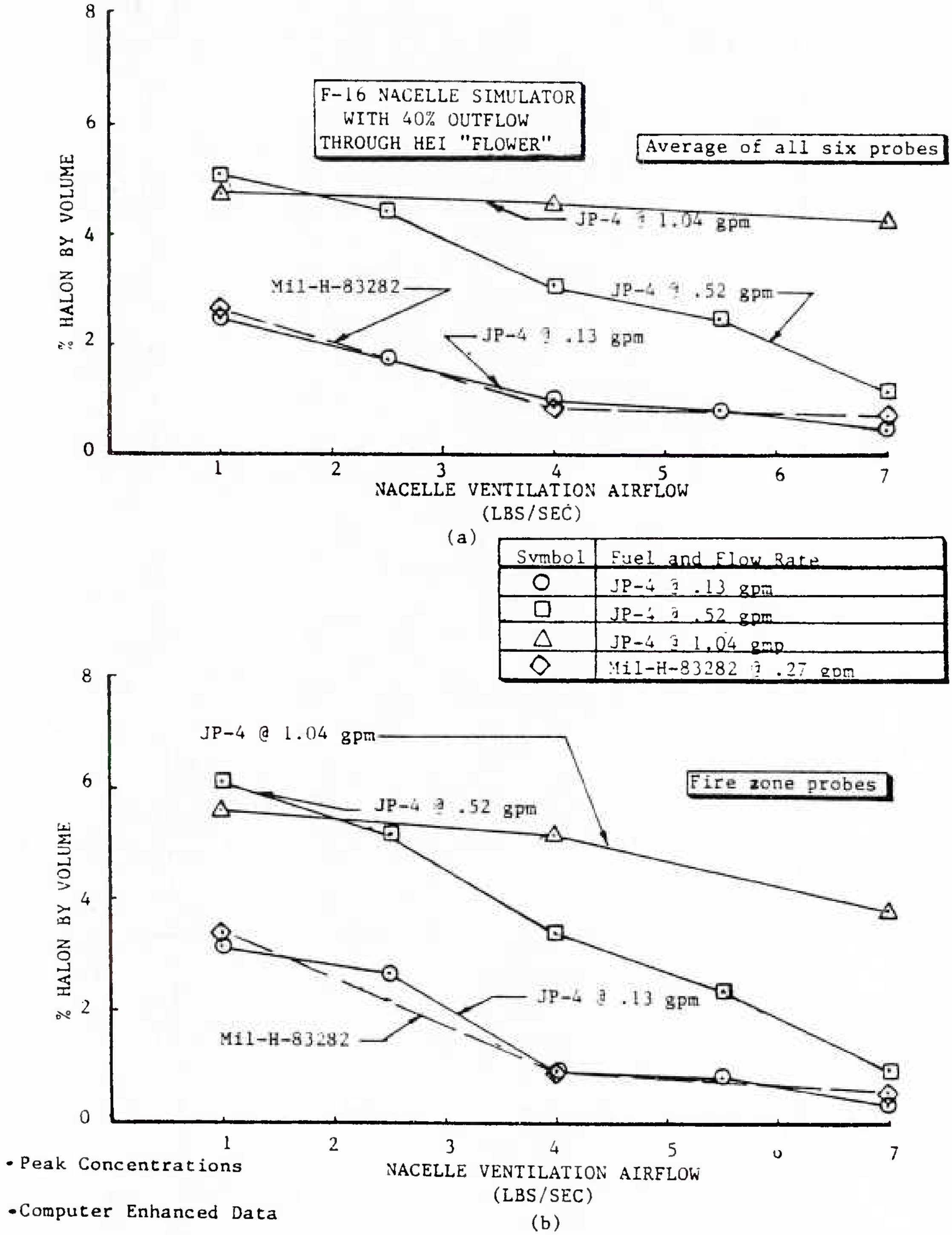
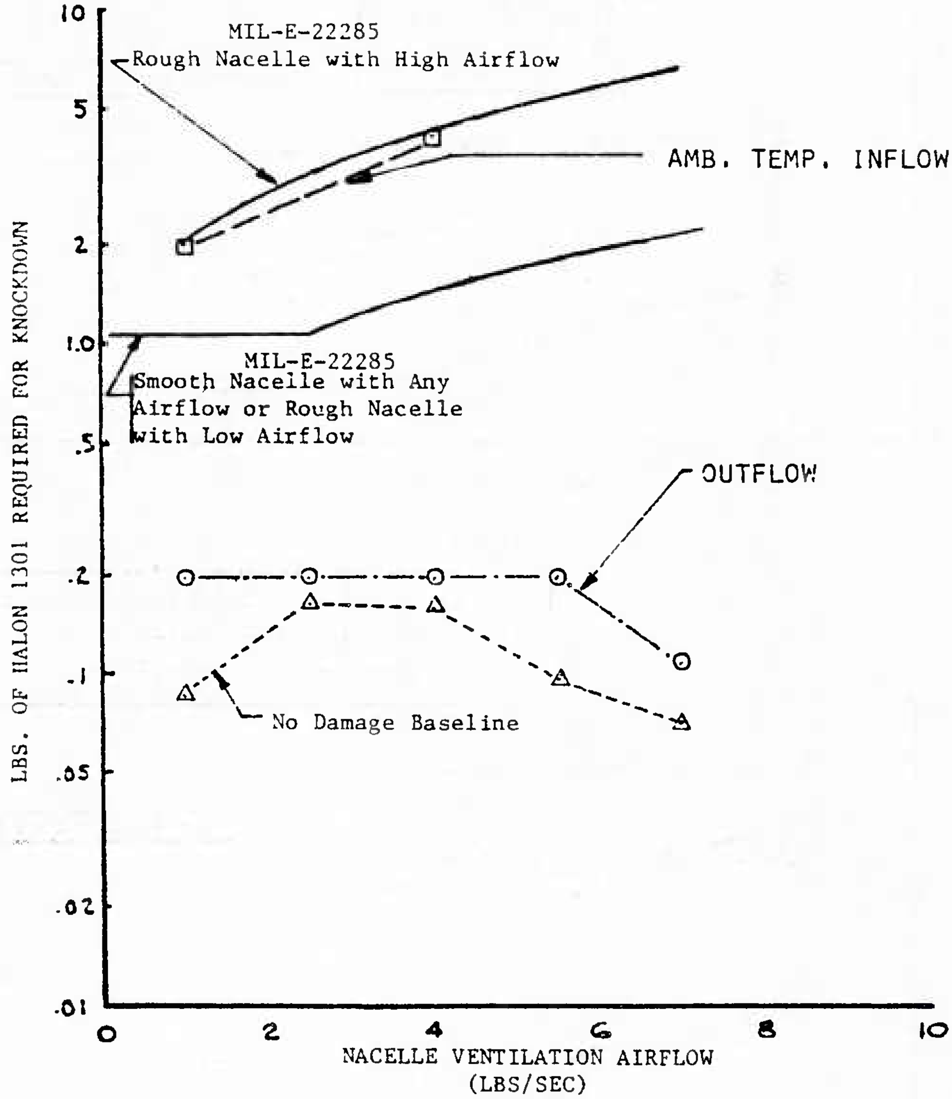



*Figure 7-16. Percent Halon 1301 Required for Knockdown of 0.13, 0.52 and 1.04 GPM JP-4 Fires and 0.27 GPM Mil-H-83282 Fires (Combat Damage Outflow)*




- "Vee-channel Flameholder in Aircraft Rib Structure
- Aircraft-type Halon Nozzle
- Short (50 to 100 millisecond) Dump using Close-coupled 600 psig Dump System

*Figure 7-17. Quantity of Halon 1301 Required for Knockdown of 0.52 gpm JP-4 Fires with Simulated Combat Damage Inflow*

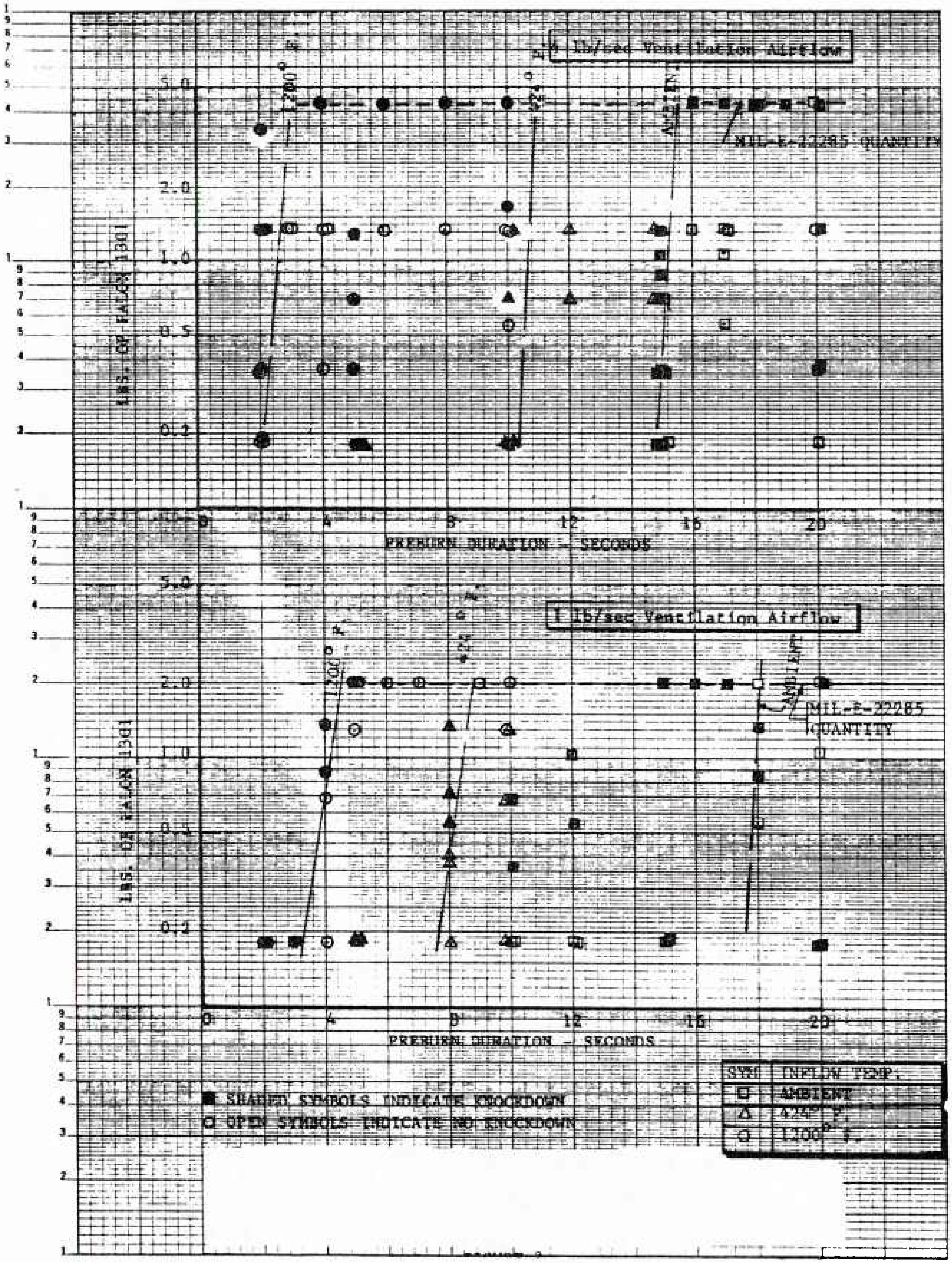



*Figure 7-18. Effect of Pre-burn Duration on Quantity of Halon 1301 Required for Knockdown of 0.52 gpm JP-4 Fires (Combat Damage Inflow)*

were more representative of the F-16 nacelle ventilation rates, testing was limited to these two values.

When the inflow was heated to 424°F, it was found that even the specification quantities of Halon 1301 could not extinguish the 0.52 GPM fires. From observation of the TV monitor, the additional air was causing a much leaner fire than during previous test phases in which 0.52 GPM JP-4 fires were employed. Various parts of the F-16 nacelle simulator were being heated to white-hot temperatures; even if the agent knocked the fire down, the additional fuel would be reignited by these hot surfaces. Some melting of aluminum engine components and simulator parts substantiated the indication that the fires were hotter during the inflow tests than previous tests. Spattered metal began to appear on the viewing window and portions of engine components began to disappear. Therefore, the emphasis of the inflow tests was shifted to reducing the pre-burn period to the point where normal agent quantities were effective. (This assumes that a similar fire in an actual airplane would need a rapid response detection/agent discharge system to be survivable). A minimum number of fire tests were performed with sufficiently short pre-burn times to eliminate damage to the test article as a test variable. Hence, the 0.52 GPM JP-4 fires were repeated at each of the three bleed air temperatures, with the pre-burn period varied downward from the initial 20 seconds until consistent knockdown occurred.

For the 1 pps ventilation airflow cases with ambient inflow, it was found that the agent generally should be released within 17 seconds after ignition for consistent knockdown. When the inflow temperature was increased to 424°F, consistent knockdown required agent release within 10 seconds. With 1200°F inflow, the agent release had to occur within 5 seconds or again the internal surfaces would become hot enough that specification charges were inadequate. The data record of these fires is illustrated in Figure 7-18.

For the several temperatures of inflow, the fact that the knockdown lines are nearly vertical indicates that the size of the Halon 1301 charge had little effect on the probability of extinguishment and that the duration of the pre-burn period was the most important variable. Fire tests were also conducted with only nitrogen in the dump tank, but nitrogen did not extinguish the fires, even for pre-burn periods of 1 and 2 seconds.

These knockdown data points were somewhat less consistent than those accumulated during the earlier phases of testing and the three knockdowns out of four criteria could not be consistently employed. Probably the inconsistency was largely due to the Halon measurement uncertainties introduced by three and four stage fill operations.

The data acquired at 4 pps ventilation airflow were even less consistent and more judgment was required to make similar conclusions. The data scatter was probably due to the measurement errors in the multi-stage fill operations and partly due to the "snapping" procedure; it was generally necessary to ignite most of these fires at 1 pps and "snap" to 4 pps. This involved several manual operations and as the pre-burn period became shorter, the timing accuracy became a significant factor in test repeatability.

The knockdown points, as established using Figure 7-18, are illustrated in Figure 7-19. It appears that the inflow temperature affects how rapidly the agent must be deployed, that the ventilation flowrate has a minor effect and that some sort of automatic fast-response detection release system might be required to effectively deal with this type of fire.

## 7.6 Combat Damage Outflow Agent Concentration Tests

Agent concentration tests were conducted with the simulated combat damage outflow. Because such large quantities of Halon 1301 had been used in the fire tests, much greater Halon concentrations were measured than for earlier tests. One or more of the Halonizers often saturated with the largest charges. They would indicate that the concentration was increasing up to about 24% at which time they would saturate and remain at that level until the actual concentration began to decrease again. Beckman manuals indicate that the concentration data become inaccurate beyond 20%.

The relationship between the Halon concentration in the test section and the quantity of Halon 1301 actually dumped is illustrated in Figure 7-20. Up to the 20% concentration level noted above as the limit of data confidence, these data were similar to those in Figure 7-14 for the combat damage outflow testing except that they begin at about 4% concentration where the earlier data stopped. This does not mean that Halon concentrations of 10% and above

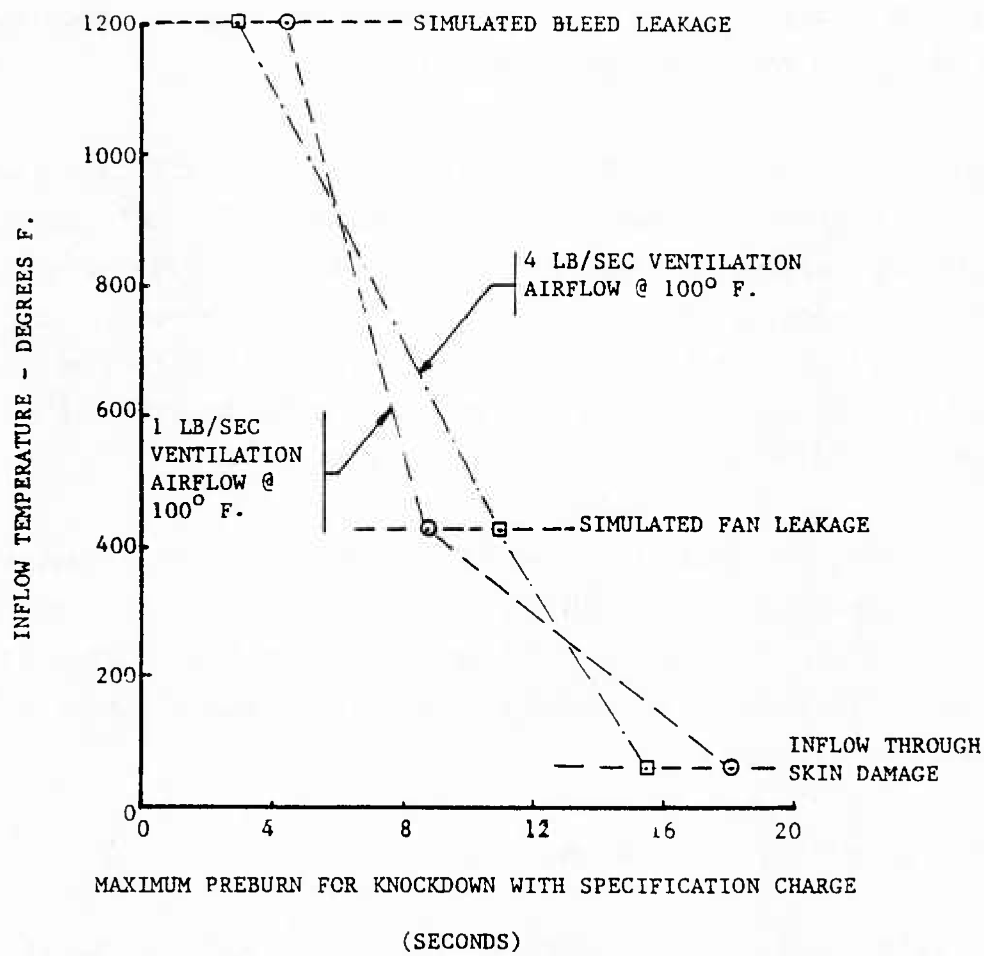



*Figure 7-19. Maximum Pre-burn Duration for Knockdown with Halon 1301 Charge per Mil-E-22285 (Combat Damage Inflow)*

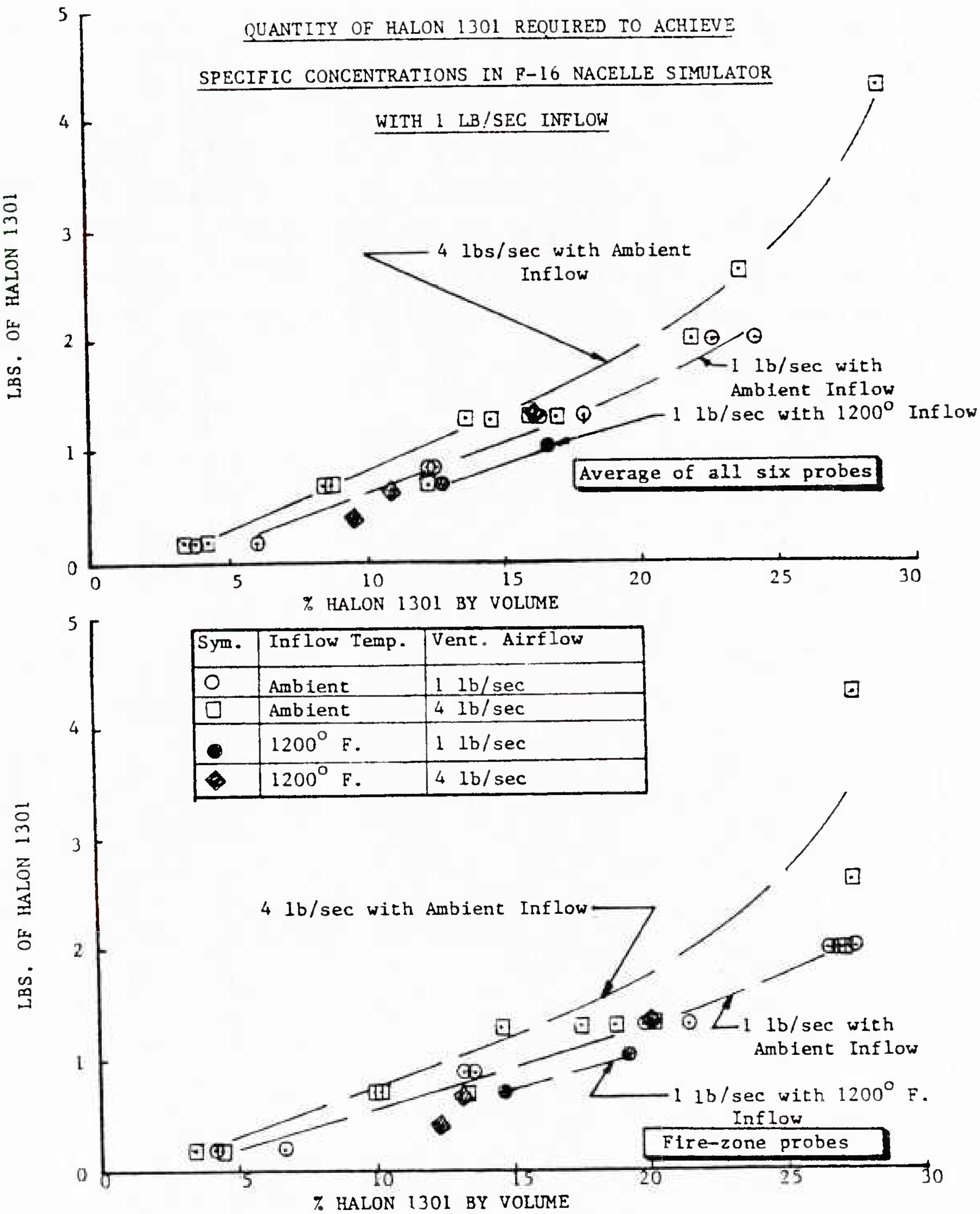



*Figure 7-20. Quantity of Halon 1301 Required to Achieve Specific Concentrations in F-16 Nacelle Simulator (Combat Damage Inflow)*

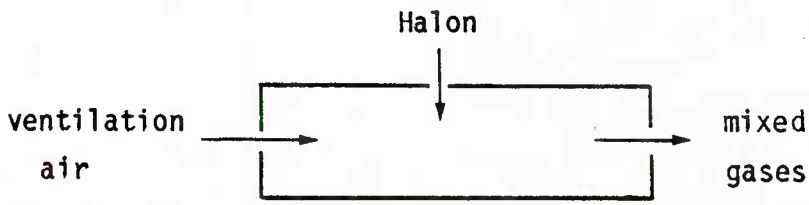
provided additional extinguishing capability. As noted in the discussion of Figure 7-18, the smallest charges were almost as effective as the very large ones. It was the duration of the preburn period which had the largest effect on the probability of knockdown.

Figure 7-20 also illustrates the effect of the inflow temperature on the Halon concentration measured in the test section. A minimum number of 1200°F bleed test points were acquired and they are shown with shaded symbols. They indicate that the concentration was about 10% higher than the comparable cases with ambient inflow. This was not considered to be a significant change.

## 8.0 ANALYSIS

### 8.1 Agent Quantity Required for Extinguishment

Consider an engine compartment with inflows of ventilation air flow on Halon that mix and flow out of the compartment as sketched below:




ENGINE COMPARTMENT

The quantity of Halon required can be determined from the following equations (Ref. 8):

$$W = \frac{PCM_e}{RT} [W_a t / \rho_a + V] \qquad (1)$$

Where,

- $W$ = weight of extinguishant
- $P$ = absolute pressure
- $C$ = percent concentration of agent (by volume) required for extinguishant
- $M_e$ = molecular weight of extinguishant
- $R$ = universal gas constant
- $T$ = ambient temperature
- $W_a$ = mass flow rate of ventilation air
- $\rho_a$ = air density
- $V$ = volume of compartment
- $t$ = discharge time

For a 6% concentration, a 1-second discharge time and standard day conditions the equation becomes:

$$W = .314\ W_a + .0236\ V \text{ (Halon 1301)} \qquad (2)$$
$$W = .442\ W_a + .0333\ V \text{ (Halon 1202)}$$

The formula for Halon 1301 is in general agreement with MIL-E-22285 which specifies:

$$W = .25\, W_a + .02V$$

Ref. 8 indicates that a 6% concentration is not required for Halon 1202 and specifies the following equation based on a 4.2% concentration:

$$W = .303\, W_a + .023V$$

This relationship is apparently based on preliminary data from tests performed in the 1950's, but a literature search failed to produce formal documentation of the tests. Documentation obtained indicated that Halon 1202 was superior for fighting pan fires, but there was no evidence that the same conclusion would pertain to fires with ventilation airflow.

## 8.2 Performance of Halon 1202

As indicated in Section 7.0, more Halon 1202 than Halon 1301 was required to extinguish comparable fires, both in terms of pounds of agent and volumetric concentration in the fire-zone of the AEN test section.

During early experiments with Halon 1202 (before the close-coupled dump system was designed), the agent was found to collect in pools in the distribution system plumbing because of its relatively high density (19 lbs/gal) and low vapor pressure (14.7 psia at 73$^{o}$F). It is possible that a similar situation occurred within the AEN test section in the range of ventilation airflow velocities tested. Halon concentrations were not consistently highest at the bottom of the F-16 nacelle simulator, but since less than an ounce of Halon 1202 was being injected, it could easily have missed the probes which were about 4 inches above the lowest point.

Figure 7-6 indicated that a 3% concentration of Halon 1301, in the fire-zone, extinguished the baseline 0.13 gpm JP-4 fires. However, a 5% concentration of Halon 1202 was required for these same fires, a 67% increase. As indicated by Figure 7-10, the 0.52 GPM JP-4 fires required up to a 8.5% concentration of Halon 1301. An even higher concentration of Halon 1202 would probably have been required if this agent had been tested on these fires.

## 8.3 Optimum Agent Discharge Rate

When the close-coupled dump system was initially used with Halon 1301, comparison of the results with those acquired with the earlier remote dump system (Figure 7-1) indicated substantially less agent was required to extinguish the same fire in the newer system. While the earlier data acquired with the remote dump system was felt to be inaccurate because of airflow data scatter, the trend probably can be believed. When a given quantity of agent was discharged in 0.05 second, it was a more effective extinguishant than if it was discharged in 1/4, 1/2 or 1 second.

From these data, the 1/2-second discharge recommended by MIL-E-22285 should be examined carefully and a revision considered once sufficient test data are available to confirm this preliminary observation. During the subject AEN tests it seemed that, for a given amount of agent, providing the maximum peak fire-zone concentration was much more important in achieving knockdown than extending a lower fire-zone concentration over a longer time.

The half second discharge specification was probably included to allow time for cooling and to prevent flash-back from one region of the engine compartment to another. Some additional caution is needed before a change in the specification should be recommended because the AEN "Standard" fire test may not simulate all engine compartment situations where flash-back might occur. Because the fuel injection was continued for another 5 seconds after the agent discharge in all the subject tests, however, it appears that the high concentration short duration burst is the most effective way to employ the agent.

## 8.4 Variations in Flame Intensity

Temperatures were not measured in the center of the fire zone during any of the testing. The zone 1 and 2 air temperature thermocouples, which were closest to the fire zone, failed and were replaced often during the tests employing the F-16 Nacelle Simulator. Visual observation of the flame color on the TV monitor, however, indicated that more intense fires were experienced with certain combinations of fuel and ventilation air, usually those just slightly leaner than the "ideal" 14.8:1 air to fuel ratio.

Much hotter looking fires were experienced and much more damage to the aluminum engine components was observed during the inflow tests than during F-16 nacelle simulator baseline tests with the same total airflow and the same fuel flow rate. This was probably the result of the simulated combat damage inflow being introduced adjacent to the flameholder. The inflow may have promoted higher temperature combustion both by supplying additional oxygen and stimulating the mixing process.

Since the Halon extinguishes the fire by reacting with the free radicals in the combustion zone at the edge of the flame "plume" and a larger plume was anticipated with the higher fuel flow rates, the agent quantity required for knockdown would be predicted to increase as the fuel flow rate was increased. As shown in Figure 7-13, this was generally observed except in those cases where the air to fuel ratio was too rich or too lean. In the cases where there was too much air, the fires were unstable and hard to ignite. In the cases where there was too much fuel, as at the lowest airflow rate at 1.02 GPM on Figure 7-13, less agent was required than with a lower 0.52 GPM fuel flow rate.

### 8.5 Variation in Agent Concentration Required with Velocity

For all the fires experienced with the clean nacelle, the F-16 nacelle simulator and with combat damage outflow simulation, the peak concentration required for knockdown began to decrease at the highest nacelle ventilation airflow rates. These trends were similar for both the baseline tests (Figures 7-6, 7-7 and 7-10) and the combat damage outflow tests (Figures 7-15 and 7-16). Similar plots were not prepared for the combat damage inflow tests because this trend was so pronounced that the nitrogen back charge alone would extinguish the fire. For both Halon 1202 and 1301, the agent quantity required for extinguishment generally decreased as the ventilation airflow rate increased, probably indicating that the Damkoller number was aproaching unity. The quantity of agent required for extinguishment had become sufficiently small at 7 pps, for all but the 1.04 GPM JP-4 fire, that it appears that these fires could not be ignited or would be blown out without agent at a slightly higher ventilation airflow rate. Since 7 pps rate was the maximum flow rate available with the F-16 nacelle simulator, this premise could not be verified in actual tests. Only the 1.04 GPM JP-4 combat damage outflow fire (Figure 7-16) did not require a significantly lower agent concentration for extinguishment at the higher airflow rates. Again, a fuel/air ratio effect was probably illustrated here; at 7 pps, with 40% of the ventilation airflow going out through the HEI "flower", a near optimum 14.5 air to fuel ratio would be provided if 40% of the remaining nacelle ventilation airflow reached the fire zone and was available for combustion. The highest agent concentrations seemed to be required at the lowest ventilation flowrates. For Halon 1202 (Figure 7-15) a surprisingly high concentration was required to extinguish the 0.52 GPM JP-4 fires with combat damage outflow. Nearly 20%, by volume of extinguishant, was required at the lowest airflow rates. These were the result of very small Halon charges being dumped since there was much less ventilation air with which to mix the agent. This finding is relevant because 1 lb/sec is a realistic flowrate for some F-16 flight conditions.

## 9.0 CONCLUSIONS AND RECOMMENDATIONS

This test program has demonstrated the value of the AEN simulator in examining the specialized fire safety problems in an aircraft engine compartment. While considerable effort was required to develop usable procedures and refine the facility subsystems, some significant conclusions were made.

### 9.1 Evaluation of MIL-E-22285 Specifications

Based on the results of this testing, a Halon 1301 system designed to comply with MIL-E-22285 would have substantially more extinguishant than required for fire suppresson in undamaged engine compartments. This safety margin decreased for compartment fires with outflow due to simulated battle damage but was still ample.

The quantity of agent was adequate based on the simulated combat damage inflow fire tests, but the release time would have to be reduced for the agent to be effective. These conclusions are applicable to sea level static operating conditions only, since simulated altitude testing was not done. The sea level static conditions are probably more severe, from the standpoint of engine compartment fire safety, than higher altitude conditions where much higher compartment velocities or much lower air densities exist. However, more testing is required before these conclusions can be generalized to all flight conditions.

### 9.2 Performance of Halon 1202

In most cases where the performance of Halon 1202 and Halon 1301 was compared, substantially more Halon 1202 was required to achieve knockdown. Since AEN tests did not simulate ventilation airflow conditions that would exist at altitude or during high Mach number flight conditions, other situations could occur where Halon 1202 performance would be comparable or superior to Halon 1301. In addition, the limitations of the current AEN test section size and shape did not allow simulation of all types of aircraft engine compartment fires and all dynamics of agent discharge.

Additional tests with Halon 1202 are contemplated during subsequent AEN testing. Different test articles which are not as limited as the existing AEN test section and the current F-16 nacelle simulator are contemplated. It is anticipated that the altitude and high Mach number flight conditions will be simulated and that additional hot surface ignition testing will be performed. There may be situations where Halon 1202 has a clear advantage.

The AEN test results do suggest caution concerning the use of Halon 1202; substantially more agent was required to obtain comparable results than with Halon 1301, even though the limited existing documentation suggests otherwise.

### 9.3 Optimum Agent Discharge Rate

While MIL-E-22285 requires that a 6% concentration of Halon 1301 be maintained for 1/2 second in all parts of the engine compartment, AEN results suggest that discharging the agent in a manner that achieves a higher peak concentration for a shorter period of time gives better results. However, the limited test data obtained thus far does not warrant recommending any revisions to the specification. Additional tests are needed on undamaged compartments to assess the effects of compartment configuration and altitude simulation on extinguishant requirements. Additional simulated combat damage fire tests are required to evaluate agent escape during outflow or agent dilution during inflow. Later phases of the AEN testing are intended to help quantify the effect of these conditions on amount of agent required. The availability of additional agent as a safety factor and as an allowance for combat damage is appropriate until additional test data are available.

Testing planned for the AEN during FY 85 through FY 88 will include an extended program to define optimum agent discharge dynamics as well as optimum agent distribution systems and evaluation of advanced agents. It is recommended that review and potential revision of MIL-E-22285 be undertaken as that program progresses.

### 9.4 Fast Response Automatic Detection/Release System

A new study is required to provide satisfactory protection against the type of engine compartment combat damage where a jet of air and a moderate quantity of fuel create the high combustion temperatures experienced in the combat damage inflow testing. Current systems are too slow to extinguish such a fire before major damage could be done.

Following a visual fire warning in the cockpit, it is unlikely that a pilot would activate the Halon 1301 system within 2 seconds with current aircraft and flight procedures. The surface temperatures of components near the fire would probably be elevated sufficiently to cause hot surface reignition of the fuel if the system was fired after a normal time delay.

Since the high temperature inflow simulating a bleed duct leak led to reignition, it is possible that a hot air detection system might be of value. A system such as the Graviner F-111 system that was tested in this program, might also provide protection. With either, the agent would have to be released so rapidly that an agent release computer, monitoring the detection system, would probably be required. Such a system probably should be added to, rather than installed in place of, the type of agent system currently in use.

More testing needs to be done to examine this requirement in detail. Examining this type of hazard at high altitude and high Mach number flight conditions will also be required to ensure that the most complete protection available is recommended.

### 9.5 F-16 Hot Surface Ignition Testing

Tests were conducted in the AEN facility to evaluate the effect on fire safety of deleting the insulation from a bleed air duct on the right side of the F-100 engine on the F-16 airplane. Of particular concern was that the elevated duct surface temperatures might lead to ignition of leaking airplane fluids. Hot surface ignition temperatures with appropriate ventilation airflows were determined for JP-4 fuel, and the lubricating oil and hydraulic fluids used in the F-16. The data were then analyzed by General Dynamics (Reference 3) to prepare a risk assessment for the proposed design change. The conclusion was that the risk was acceptable and insulation of the bleed air duct was not required, thus saving the Air Force about $20 million. Appendix A is a copy of the referenced General Dynamics test and analysis report.

## 9.6 Nitrogen Enriched Air Extinguishant Testing

Since the C-5A airplane utilizes the liquid nitrogen system for compartment fire protection as well as fuel tank inerting, it followed that the nitrogen enriched air (NEA) produced by an on-board inert gas generator system (OBIGGS) should also be considered for compartment fire protection. Based on testing in the AEN facility (Appendix B), it was concluded that NEA could be used satisfactorily as an engine compartment fire extinguishant.

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APPENDIX A

THIS APPENDIX IS A COPY OF THE GENERAL DYNAMICS REPORT REFERRED TO IN SECTION 9.5

16PR2771
4 FEBRUARY, 1983

CCP 5704

# F-16 ENGINE NACELLE FIRE-PREVENTION REQUIREMENTS STUDY

(CDRL SEQUENCE NUMBER A045)
CONTRACT NO. F33657-75-C-310


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ACKNOWLEDGEMENTS

Several people contributed to this study through extra effort. The author takes this opportunity to thank those people for their help.

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## FOREWORD

ACSN (Advance Change/Study Notice) 1709 directed General Dynamics to prepare a CCP (Contract Change Proposal) to conduct an experimental study to measure the minimum engine bleed-air duct temperature that will cause the spontaneous ignition of fuel and hydraulic oils in a simulated F-16 ventilated nacelle. The results of the study involving realistic F-16 nacelle/engine bleed duct configurations and nacelle ventilation rates will be used to support a recommendation either to insulate or not insulate the engine bleed-air ducts.

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## SYMBOLS AND NOMENCLATURE

| | |
|---|---|
| ACSN | Advanced Change/Study Notice |
| AEN | Aircraft Engine Nacelle |
| AFAPL | Air Force Aero Propulsion Laboratory |
| AFB | Air Force Base |
| cc | Cubic Centimeter |
| CCP | Contract Change Proposal |
| CFE | Contractor Furnished Equipment |
| CIP | Component Improvement Program |
| $^{o}F$ | Degrees Fahrenheit |
| fps | feet per second |
| ft | feet |
| IGN. | Ignition |
| INJ. | Injection |
| METH. | Method |
| MIT | Minimum Ignition Temperature |
| P&WA/GPD | Pratt & Whitney Aircraft/Government Products Division |
| psig | pounds per square inch gage |
| R | radius |
| sec | second |
| T/C | Thermocouple |
| TV | Television |
| UV | Ultra Violet |
| W/O | Without |

# 1 INTRODUCTION

This report summarizes an experimental study, the test portion of which was conducted in the Air Force Aero Propulsion Laboratory's Aircraft Engine Nacelle Fire Test Simulator Facility during the time period of 12 April through 4 June, 1982.

## 1.1 BACKGROUND

Since the original nacelle design of the F-15, there has been some uncertainty about the need for the F100 engine bleed-air ducts to be insulated for fire prevention. Although nacelle ventilation complied with Reference 1 and 2 requirements for minimum air velocities, suitable test facilities were not available for verification at that time and a conservative decision was made to insulate the ducts. This insulation (CFE - Contracter Furnished Equipment) was later removed from all fleet aircraft engines because of interference/chafing problems. P&WA initiated an F100 Component Improvement Program Task (CIP Task No. 837) to provide ducts having integral insulation as engine bill-of-material parts to solve these problems.

With recently completed nacelle-fire test facilities, it is now possible to more accurately define the conditions at which hot bleed-air ducts will ignite combustible mixtures in a ventilated nacelle. Preliminary studies indicated that there was a good chance that the results of tests proposed by this study would verify the safety of uninsulated ducts and that the cost of insulation could be avoided.

## 1.2 OBJECTIVE AND SCOPE

The primary objective of this experimental study was to obtain sufficient data to determine if the F100-PW-200 engine bleed-air ducts should be insulated for the purpose of fire prevention. The test program was designed to simulate as accurately as possible a wide range of potential fire conditions in the F-16 nacelle. Variations in combustible mixtures, average nacelle ventilation velocity, and bleed-air-duct temperatures were investigated for several test hardware configurations.

## 2 SUMMARY

Fuel and oil will occasionally leak into aircraft engine nacelles, due to fuel and oil-containing component failures, where they may mix with the surrounding ventilation air and perhaps create a combustible mixture. If a combustible mixture exists and if it also comes in contact with an ignition source, a fire will occur.

Within the F-16 engine nacelle the most likely source of ignition is the hot engine-bleed-air ducts. The objective of this program, therefore, was to (1) determine the minimum bleed-air duct temperatures that would ignite a combustible mixture, (2) perform a safety/risk analysis to estimate the probability of F-16 nacelle fires, and (3) recommend whether or not the bleed-air ducts should be insulated to reduce the estimated number of nacelle fires.

A comprehensive test program was conducted to measure the minimum bleed-air-duct temperature that will cause spontaneous ignition of fuel and oils in a simulated engine nacelle with forced ventilation. Electrically heated sections of the F100-PW-200 bleed-air ducts were mounted in a simulated, full-scale nacelle through which ventilation air at sea level pressure flowed at average velocities from 0 to 10 feet per second. (The average ventilation velocity in the F-16 nacelle varies from a minimum of 6 ft/sec during ground operations and take-off up to 100 ft/sec in flight depending on flight conditions.) Three hardware configurations were tested.

1. A bare bleed-air duct.
2. The duct including a clamp separated from the duct by a cushion material (stainless steel mesh).
3. The duct with clamp and mesh plus an engine augmentor fuel-flow controller and a section of the oil tank located as they are in the F-16 nacelle. The controller and tank, located upstream of the duct, provide obstacles to the ventilation flow and therefore a more accurate simulation of the local flow conditions around the duct.

The combustible fluids, consisting of JP-4 fuel and three oils (hydraulic oils MIL-H-5606 and MIL-H-83282, and engine oil MIL-L-7808), were applied to the hot duct by both spraying and dripping.

The hardware configuration, ventilation flow velocity, combustible fluid, and method of fluid application represent four of the five independent variables affecting the hot-duct ignition temperature. The fifth and equally important variable is the rate (cc per second) at which the fluids must be dripped or sprayed on the hot duct in order to produce a combustible mixture. Flow rates too large or too small will not cause ignition. In general the fluid flow required to produce a combustible mixture depends on the magnitude of the hot-surface temperature. Therefore, preliminary in-house testing was conducted to determine the flow rates required (for each fluid) to produce a combustible mixture for both spray and drip applications. Various spray nozzles, producing different droplet sizes and spray patterns, were also evaluated in order to select those producing the most ignitable mixtures. The combination of flow rates and nozzles selected for both the spray and drip applications were then used for the tests described herein to measure hot-surface ignition temperatures.

The basic procedure involved in measuring hot-surface ignition temperatures was first to select a given set of conditions consisting of hardware configuration, ventilation velocity, combustible fluid, and method of fluid application. Next, the duct was heated to a temperature high enough to insure ignition of a combustible mixture (1400 °F for example) and then the combustible fluid was applied at the required flow rate for a period of 5 to 10 seconds. If ignition occurred, the duct temperature was reduced 25 to 50 °F and the test was repeated. This process was repeated until ignition ceased and a "preliminary minimum" ignition temperature was declared. Additional testing was then conducted at duct temperatures in the neighborhood of this "preliminary minimum" for verification that a credible minimum was established. As the duct temperature approached the minimum required for igniton, the probability of ignition became very small; several attempts were frequently required to obtain ignition as the duct temperature approached within 50 $^{o}$F of the minimum. This process was systematically repeated at each set of conditions of interest to define the minimum hot-duct ignition temperatures for the complete range of test conditions (hardware configurations, ventilation velocities, combustible fluids, and method of fluid application).

Representative results of the test program are summerized in Table 2-1 that gives the minimum ignition temperature for an average ventilation velocity of 6 ft/sec (the minimum in the F-16 nacelle). At higher ventilation velocities and also at lower air pressures, the ignition temperatures can be expected to increase. Only the hydraulic oils, MIL-H-5606 and MIL-H-83282, were ignited at duct temperatures at or less than 1025 $^{o}$F (maximum operational temperatures of the duct) when the oils were dripped directly on the steel mesh beneath the clamp. Although the F-16 currently uses MIL-H-5606, MIL-H-83282 is being considered as a possible replacement.

TABLE 2-1

MINIMUM IGNITION TEMPERATURE - $^{o}$F
(VENTILATION VELOCITY = 6 FT/SEC)

| METHOD OF FLUID APPLICATION | SPRAY | | DRIP | | |
|---|---|---|---|---|---|
| HARDWARE CONFIGURATION | BARE DUCT | DUCT/ CLAMP | BARE DUCT | DUCT/ CLAMP | OBSTRUCTIONS |
| COMBUSTIBLE FLUID | | | | | |
| JP-4 | 1250 | 1400 | 1250 | 1100 | 1100 |
| MIL-H-5606 | 1250 | 1325 | 1200 | 1025 | 1050 |
| MIL-H-83282 | 1250 | 1050 | 1200 | 975 | 950 |
| MIL-L-7808 | 1325 | ---- | 1375 | ---- | ---- |

The general assessment of the test results is that there is not a comfortably safe margin (50 to 100 $^{\circ}F$) of difference between the maximum operating temperature of the duct and the minimum temperature at which the combustible fluids can be ignited, i.e., the duct operating temperature is too close to the ignition temperature. However, the maximum duct temperature does not occur very often. For this reason a safety/risk analysis was conducted to estimate the number of F-16s expected to be lost due to nacelle fires during the remaining operational lifetime of the fleet. This analysis included

1. The number of combustible fluid leaks in the engine nacelle per F-16 flight hour. (Ground operations are not considered since the maximum duct temperature will be 875 $^{\circ}F$, which is less than the ignition temperature of the fluids considered for 6 feet per second ventilation velocity.) The leak frequency is based on operational F100 experience in both the F-15 and F-16 aircraft. Although not included in the analysis, the cause of many of the previous leaks either have been corrected or corrections are planned.
2. The amount of flight time (hours) that the bleed-air ducts will operate at temperatures equal to or greater than those shown in Table 2-1. This estimate is based on a representative mixture of various aircraft missions.
3. An evaluation of the type and location of the possible leaks to determine the probability of a combustible fluid coming in contact with the hot duct.

The results of this analysis show the Class A Mishap rate caused by a nacelle fire with the uninsulated bleed air lines as the ignition source to be $4.52 \times 10^{-8}$ per flight hour. This equates to 0.35 Class A Mishaps during the remaining lifetime of the F-16 fleet ( 7,650,000 hours). The 0.35 is an upper bound and the actual contribution would be expected to be lower than this value because it was assumed that (1) the lines could be insulated immediately, (2) hot day conditions existed for the missions evaluated (3) nacelle pressure was always sea level ambient, (4) nacelle ventilation velocity was limited to 6 feet per second (because of ram-air effects it varies from 6 ft/sec during ground operations to a maximum of 100 ft/sec at high speed flight conditions), (5) historical flammable fluid leak rates would continue despite some known "fixes", and (6) bleed line surface temperature was 13th stage customer connect temperature (no cooling due to nacelle flow). Deviations from these assumptions are likely and would reduce the risk of fire. In summary, there does not appear to be sufficient risk reduction potential available to warrant insulating the bleed lines.

Finally, two recommendations based on the test results and safety/risk analysis are that

(1) The engine-bleed-air ducts not be insulated.

(2) The stainless-steel mesh (that provides a flexible cushion between the duct and duct clamp) be replaced with a non-porous material.

The latter recommendation, if implemented, will prevent leaking combustible fluids from being absorbed by the porous mesh and igniting at a temperature less than that for a bare duct.

# 3 APPARATUS

## 3.1 TEST FACILITY

The AEN (Aircraft Engine Nacelle) Fire Test Simulator is one of the facilities of the Air Force Wright Aeronautical Laboratories at Wright-Patterson AFB. This facility is under the direction of the Aero Propulsion Laboratory, Fuels and Lubrication Division, Fire Protection Branch.

Figure 3-1 shows the basic geometry of the facility test section along with a very simplified building layout. The facility is described in detail by Reference 4. Physical and operational aspects of the facility, pertinent to this test, are amplified in other sections of the report as the need arises.

## 3.2 TEST ARTICLE(S)

### 3.2.1 General

Test specimens consisted of representative sections of the right hand 13th stage bleed-air duct from an F-100-PW-200 engine plus surrounding components. These duct sections and components, identified in Figure 3-2, are listed below.

1 Two six-inch segments of the Augmentor Fuel Pump Air Supply Manifold (commonly referred to as the right hand 13th-stage bleed duct)

2 Cushion Loop Clamp

3 Augmentor Fuel Pump Controller

4 Lubricating Oil Tank

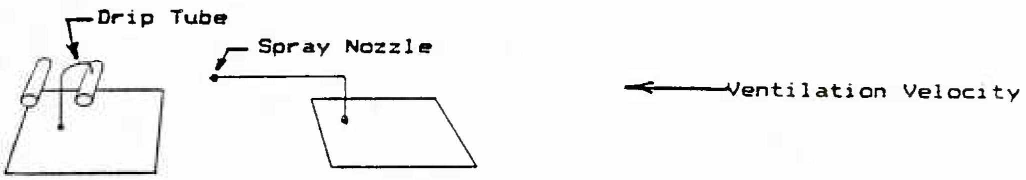
Other major components of the test configurations were:

- Apparatus for spraying and dripping the combustible fluid on the hot bleed-air duct sections.
- Electrical heating elements to heat the bleed duct sections.
- Instrumentation.

3.2.2 Test Configurations

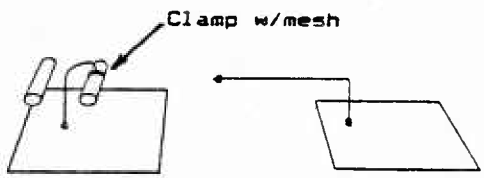
The four engine components, listed previously, were used to assemble three test configurations referred to as:

- BARE DUCT



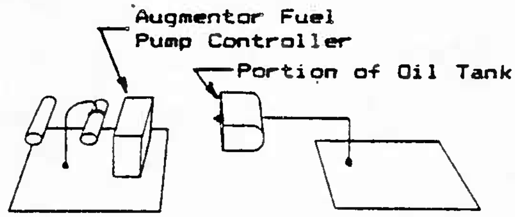

Engine compnents used: Item 1 , the two segments of the right hand 13th stage bleed duct, oriented perpendicular to the ventilating velocity. (See Figure 3-2 for orientation on the engine.)

- DUCT/CLAMP




Engine compnents used: Items 1 and 2 . The Cushion Loop Clamp, Item 2 Figure 3-2, was added to the forward (upstream) duct segment of the BARE DUCT configuration.

- OBSTRUCTIONS




Engine compnents used: Items 1 , 2 , 3 , and 4 ; Figure 3-2. The Augmenmtor Fuel Pump Controller and portion of the Lubrication Oil Tank , Items 3 and 4 respectively, were added to the DUCT/CLAMP configuration as illustrated above and by Figure 3-3.

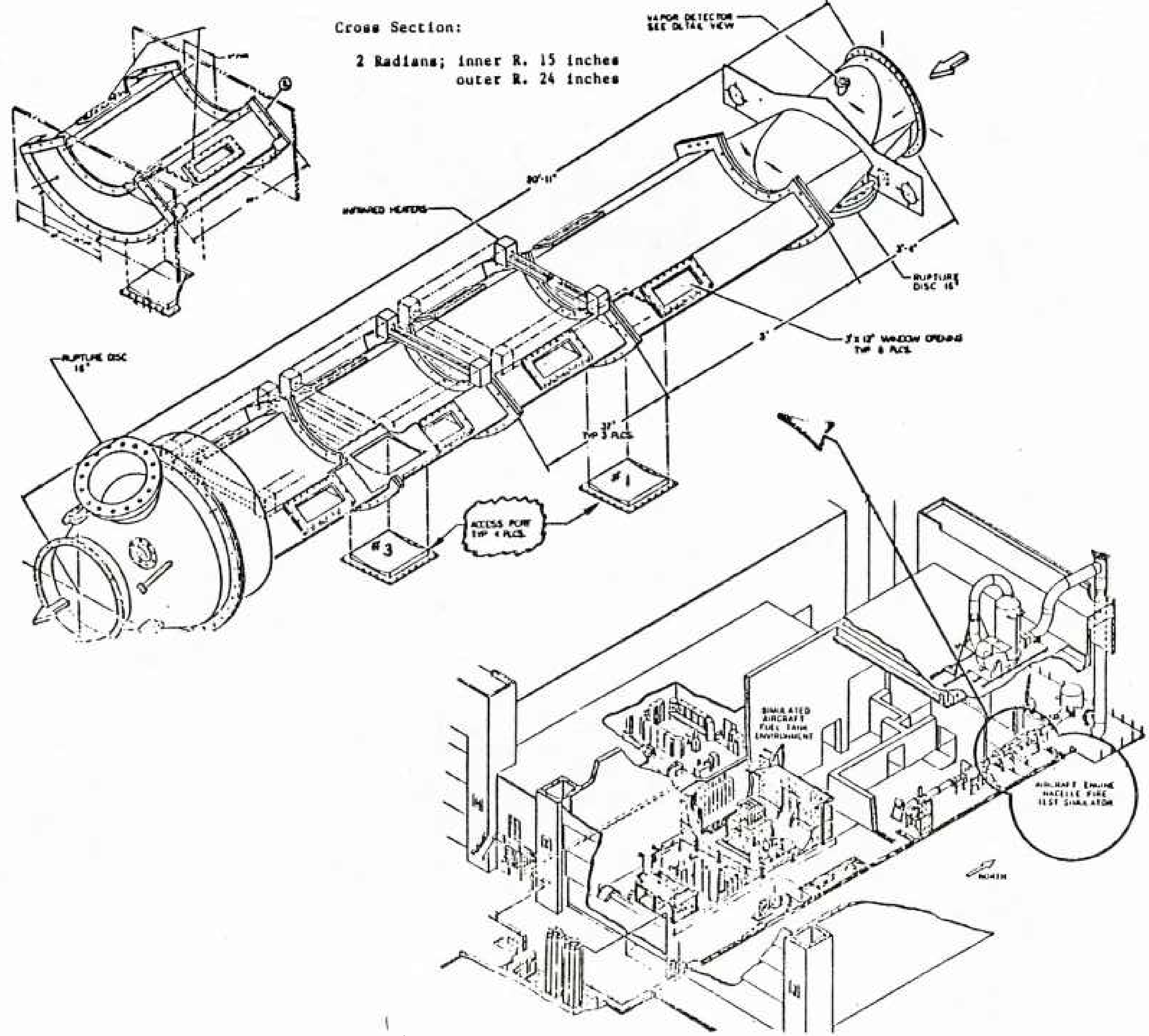
Testing sequence was in the same order as listed above.

Bleed line segment heating was accomplished electrically as shown by Figure 3-4. Setting/controlling the bleed duct temperature is discussed below and in Appendix III, DETAILED RUN PROCEDURES.

Both the drip tube and spray system remained installed at all times regardless of which system was being used at the time. A schematic of the fuel injection system is shown by Figure 3-5. Details of "managing" fuel injection are discussed in Appendix III, DETAILED RUN PROCEDURES.

Test configuration instrumentation is shown by Figures 3-6 and 3-7, BARE DUCT and DUCT/CLAMP respectively. Instrumentation for the OBSTRUCTIONS configuration was the same as that of the DUCT/CLAMP configuration. Use of the temperature data provided by thermocouples 1 through 5 is discussed in Appendix III, DETAILED RUN PROCEDURES. The "buried" thermocouple, location 6, was used in a feedback loop to position a variable transformer to control the output of a 480V power source for the heating elements.

FIGURE 3-1    AFAPL AIRCRAFT ENGINE NACELLE FIRE TEST SIMULATOR



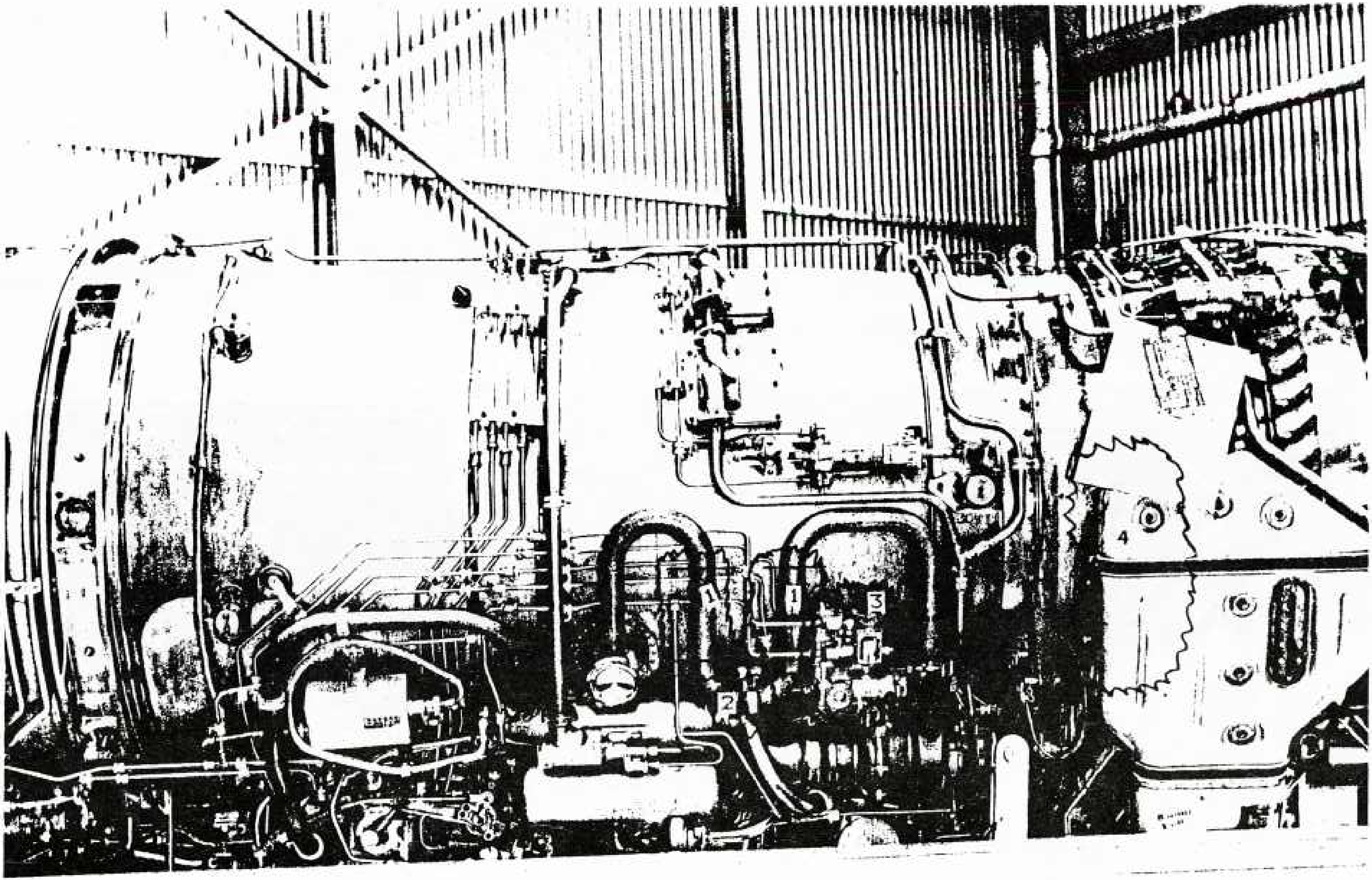



FIGURE 3-2 TEST HARDWARE/ENGINE COMPONENT IDENTIFICATION

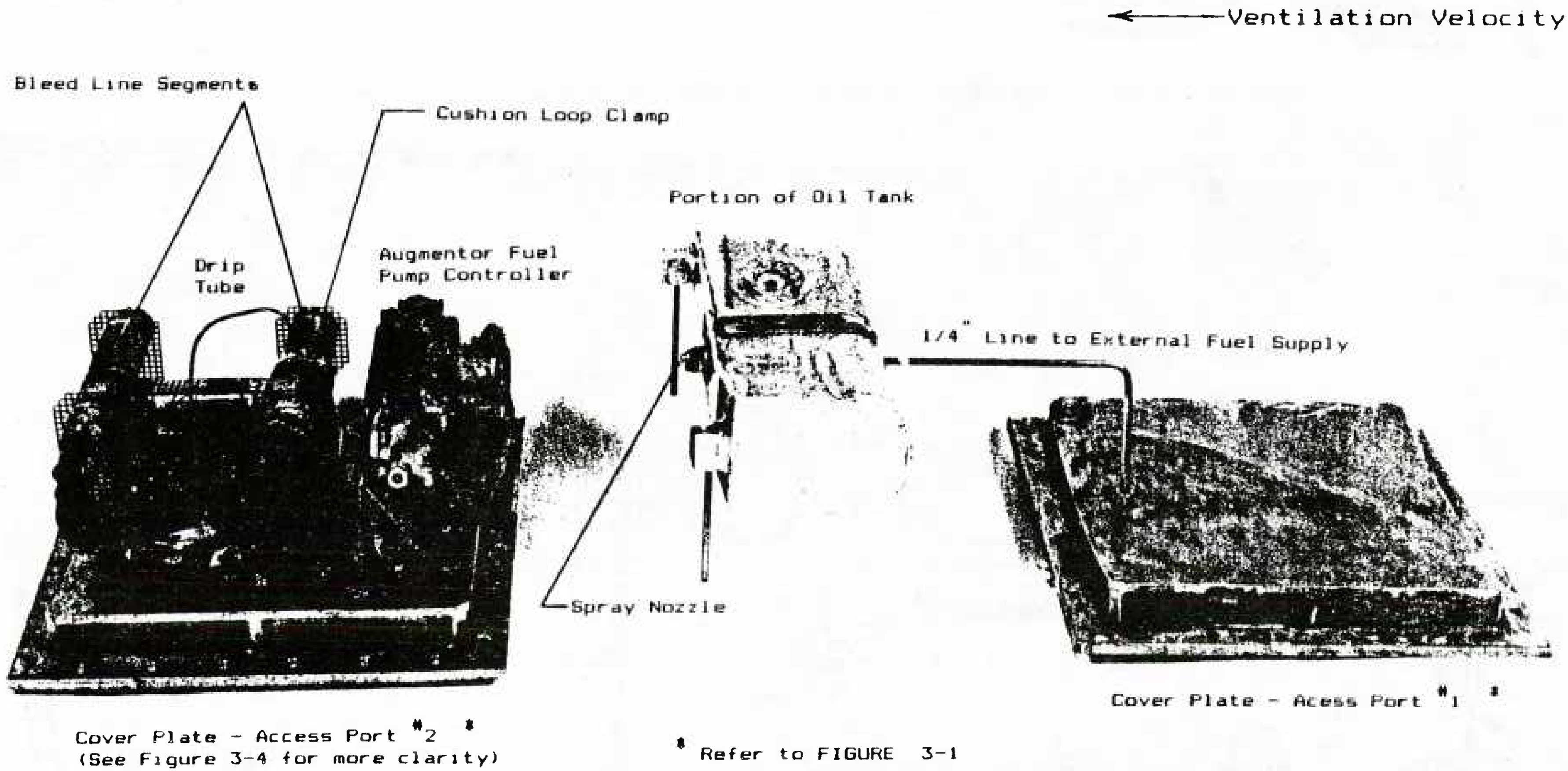



FIGURE 3-3 CONFIGURATION DESCRIPTION - OBSTRUCTIONS

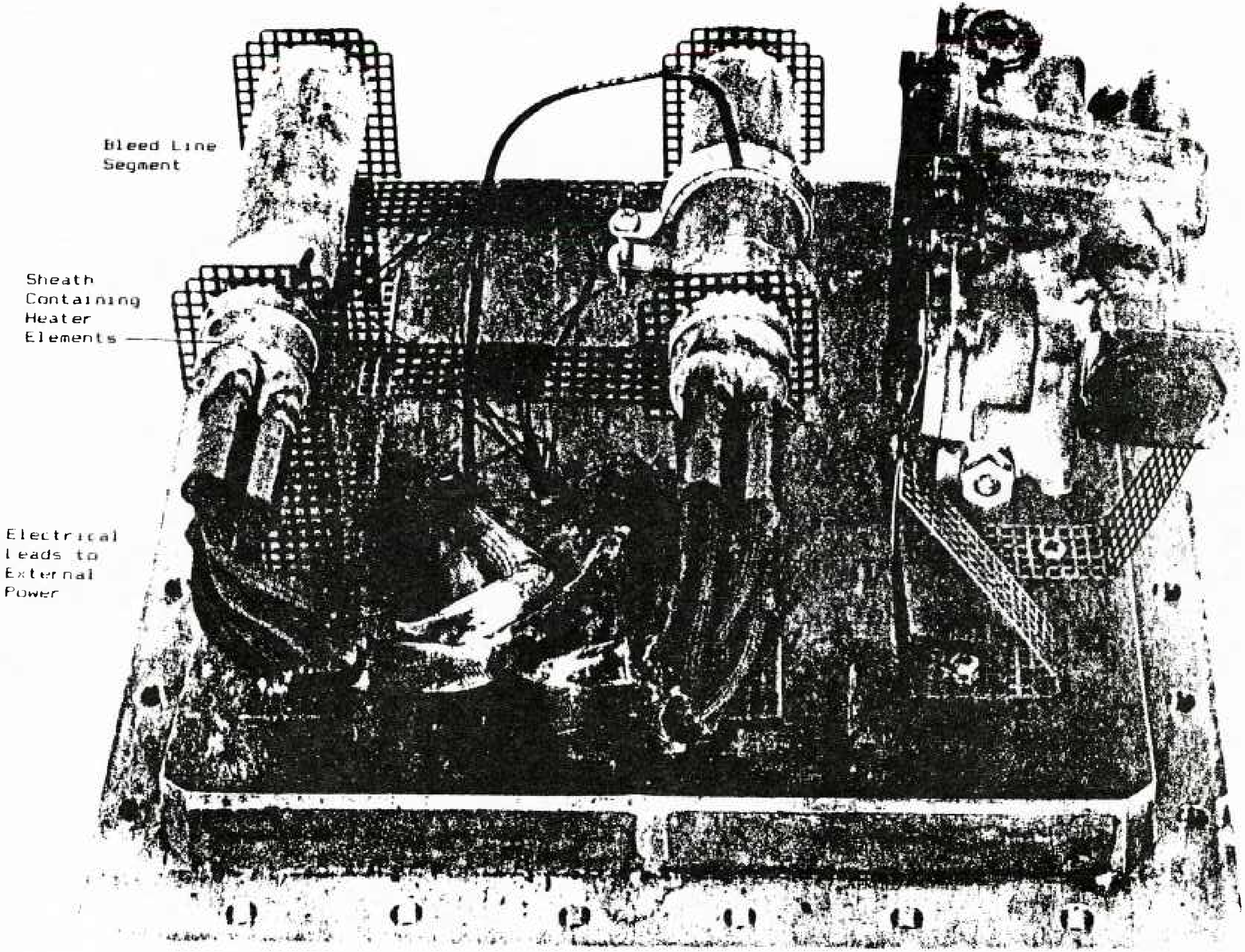



FIGURE 3-4 TEST HARDWARE INSTALLATION

FIGURE 3-5

FLUID INJECTION SYSTEM

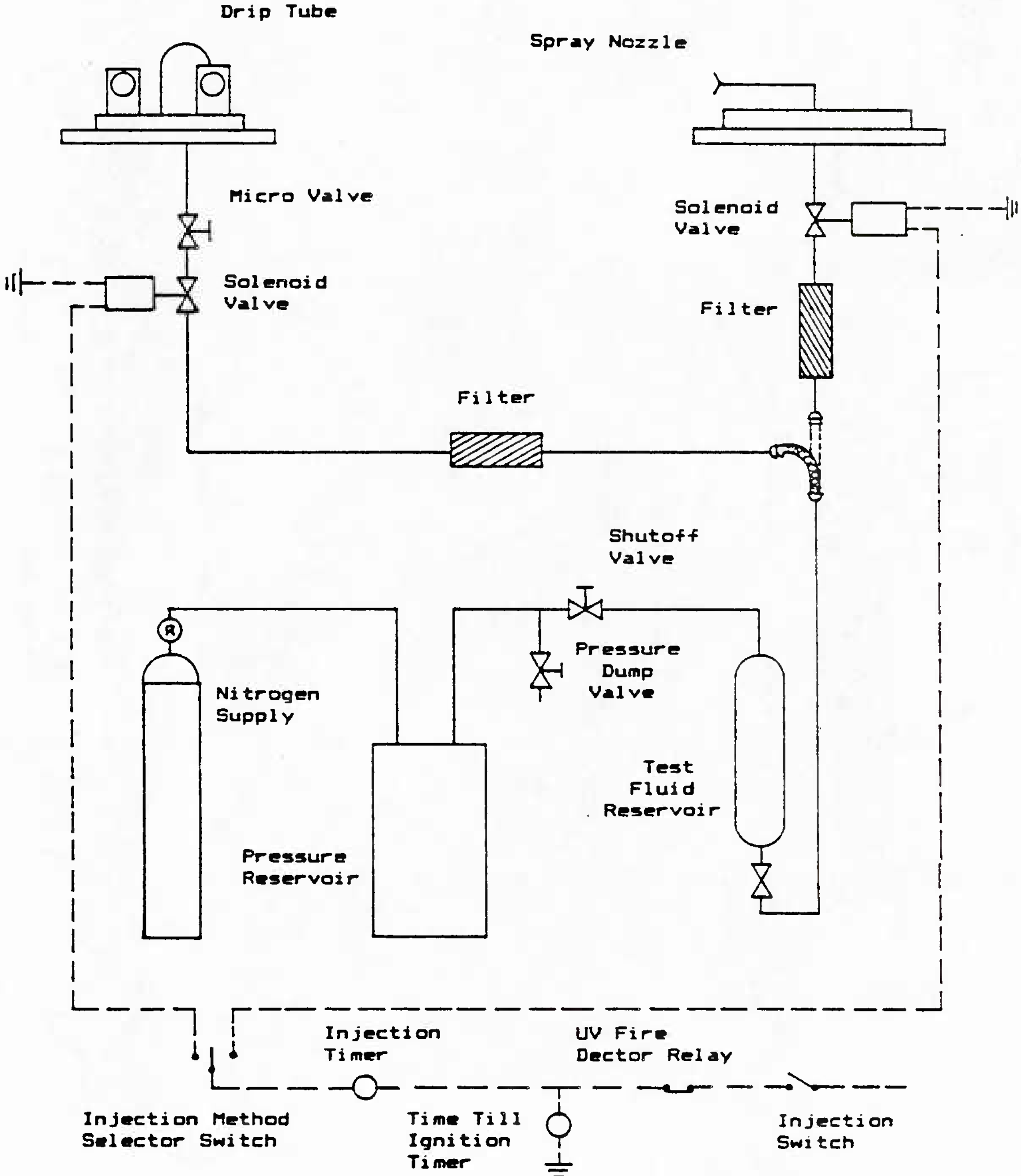


FIGURE 3-6

INSTRUMENTATION - BARE DUCT CONFIGURATION

THERMOCOUPLE IDENTIFICATION AND LOCATIONS

☐ Facility (Panel Meter No.)

○ Test Configuration (Lead No.)

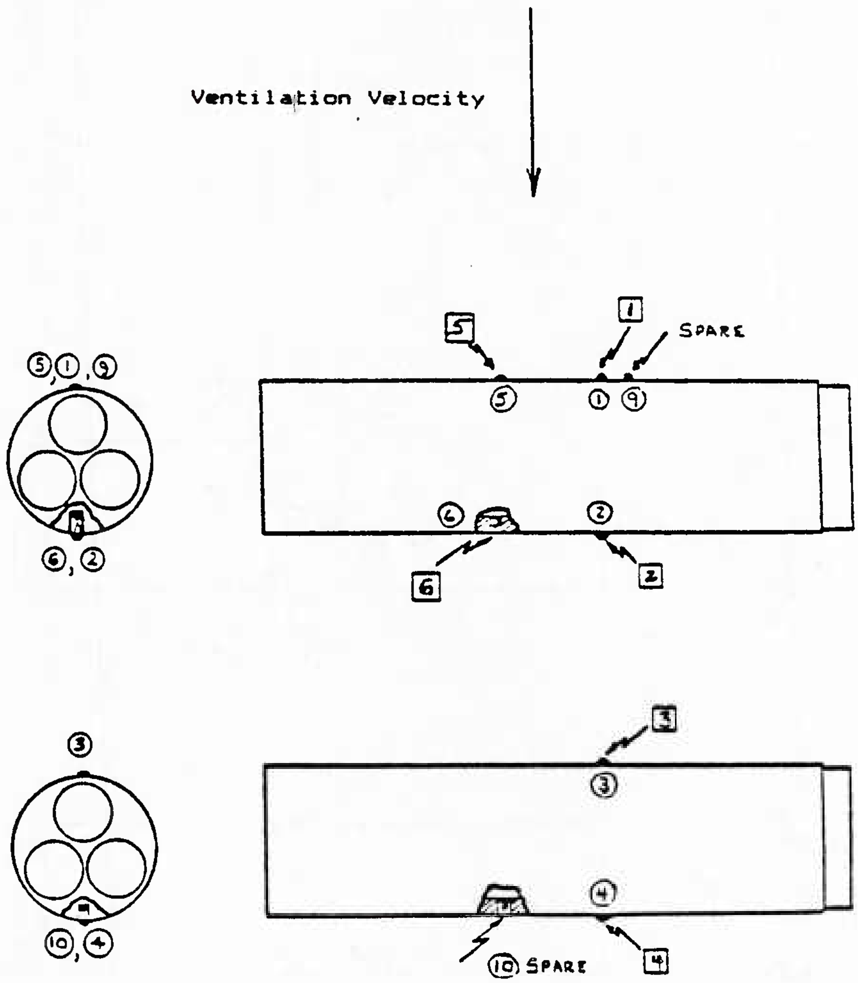


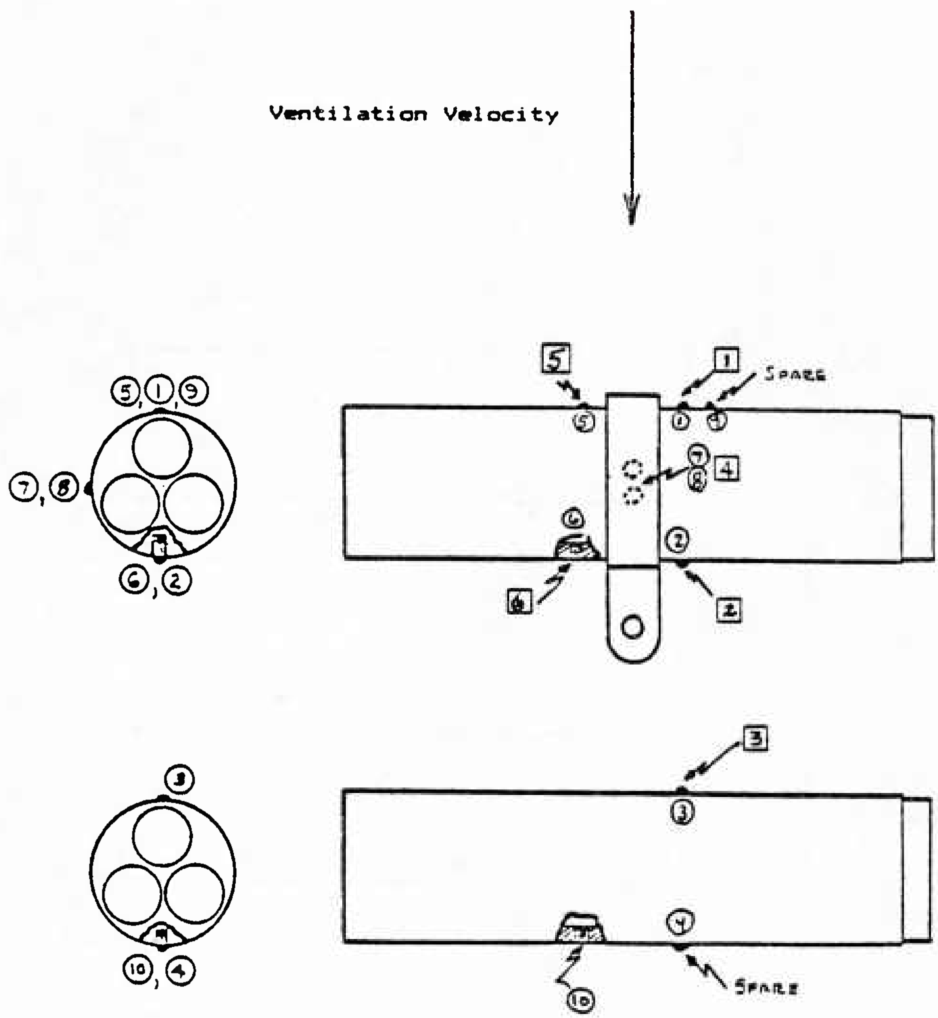
FIGURE 3-7

INSTRUMENTATION - DUCT/CLAMP CONFIGURATION

THERMOCOUPLE IDENTIFICATION AND LOCATIONS

□ Facility (Panel Meter No.)

○ Test Configuration (Lead No.)



# 4 TEST DESCRIPTION

## 4.1 TEST SETUP AND RUN PROCEDURES

### 4.1.1 Test Setup

Table 4-1 shows the combinations of test configuration, combustible fluid, and the fluid injection method that were set up to form a run configuration. Detailed set-up and pre-run procedures are described in Appendix II.

### 4.1.2 General Run Procedures

For each run configuration, the minimum ignition temperature was determined as a function of nacelle ventilating velocity in the following general manner.

> For a given value of nacelle ventilating velocity, combustible fluid was injected at various values of incrementally decreasing duct temperatures. The duct temperature for which three (3) NO IGNITIONS were recorded was defined as the minimum ignition temperature (MIT) for that nacelle ventilating velocity. This definition is conservative by a value equal to the temperature increment or portion thereof from the next higher duct temperature for which ignition occurred.

Detailed run procedures are described in Appendix III. Also included, within specific procedural steps, are amplified operational aspects of the test facility as related to this test.

TABLE 4-1

TEST SET-UP - RUN CONFIGURATIONS

| COMBUSTIBLE FLUID | MIL-H-5606 | | JP-4 | | MIL-H-83282 | | MIL-L-7808 | |
|---|---|---|---|---|---|---|---|---|
| INJECTION METHOD | SPRAY | DRIP | SPRAY | DRIP | SPRAY | DRIP | SPRAY | DRIP |
| TEST CONFIGURATION | | | | | | | | |
| BARE DUCT | X | X | X | X | X | X | X | X |
| DUCT/CLAMP | X | X | X | X | X | X | --- | --- |
| OBSTRUCTIONS | --- | X | --- | X | --- | X | --- | --- |

# 5 TEST DATA

## 5.1 TEST DATA PRESENTATION

Data for the run configurations shown in Table 4-1 are presented in three (3) formats within this report. Each succeeding format group contains more detail than the preceding group. A brief description of each format follows.

1.) Comparison of Minimum Ignition Temperature VS Nacelle Ventilating Velocity; Figures 5-1 through 5-16.

    Each figure compares the MIT's for two (2) or more run configurations. Overall, the figures summarize the test objective, ie, determine the minimum engine bleed-air duct temperature that will cause the spontaneous ignition of fuel and hydraulic oils in a simulated F-16 ventilated nacelle.

2.) Summary illustration of the data for each run configuration; Appendix IV, Figures IV-1 through IV-17.

    Each figure summarizes the ignition/no-ignition data for a run configuration by illustrating the number of ignitions as a function of attempts (number of times fuel was injected) at each temperature and velocity. The definition of MIT (Paragraph 4.1.2) is illustrated by this format. These figures are the result of accomplishing the objective of the test.

3.) Summary tables containing the test data for each point (1532 total) for each run configuration; Appendix V, Tables V-1 through V-17.

    Additional data/information contained in these tables are run and point sequence number, combustible fluid injection time, time to ignition, sample (time averaged) thermocouple values, sample (time averaged) facility nacelle velocity, and the combustible fluid injection rate and reservoir pressure.

## 5.2 TEST RESULTS

Discussion of the Comparison of Minimum Ignition Temperature figures forms a part of the basis to accomplish the objective of the study. The remaining part of accomplishing this objective, ie "support a recommendation to either insulate or not insulate the engine bleed-air ducts", rests with the results of the safety/risk analysis which is reported separately (Reference 3).

Unless otherwise noted, evaluation of these data is for an F-16 nacelle environment of:

> A minimum ventilating velocity of six (6) feet per second (Reference 5) and a maximum bleed duct temperature of 1025 $^{o}$F (Appendix VI).

Considering the conservative definition of MIT, this combination of velocity and temperature serves as a screening criteria to narrow the run configurations to those that may pose a potential problem and warrant further discussion. Only those run configurations with a MIT less than 1025 $^{o}$F for the above values of nacelle ventilating velocity are noted as susceptible to ignition.

### 5 2.1 Results For a Given Fluid

Figures 5-1 through 5-4 compare the MIT's for MIL-H-5606, JP-4, MIL-H-83282, and MIL-L-7808, respectively, with variations in test configuration and combustible fluid injection method.

For MIL-H-5606, Figure 5-1 shows no test configuration with either method of fluid injection to have an MIT value less than 1025 $^{o}$F at six (6) feet per second average ventilating velocity. Similar characteristics, ie, no MIT values for the evaluation criteria less than 1025 $^{o}$F, for JP-4 are shown by Figure 5-2.

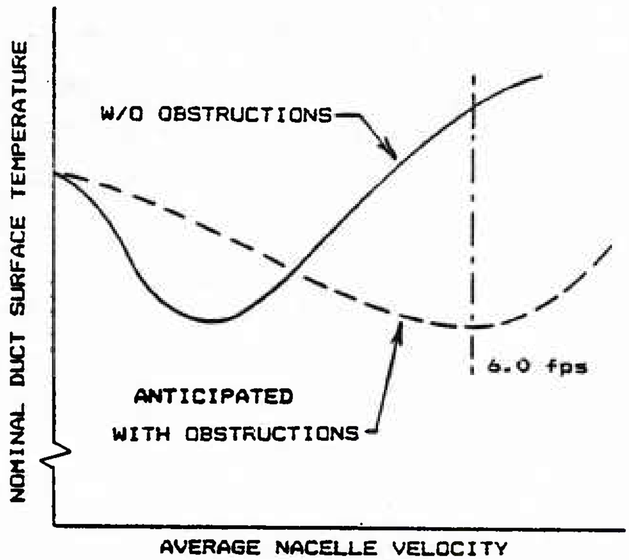
Figure 5-3 shows MIL-H-83282 to be susceptible to ignition for two test configurations with drip fuel injection. These test configurations are the DUCT/CLAMP and OBSTRUCTIONS and the MIT values are 975 and 950 $^{\circ}$F, respectively. Figure 5-4 shows no potential for ignition of MIL-L-7808 for the evaluation criteria and the test configuration (BARE DUCT) and injection methods tested. The relevancy of the limited data on MIL-L-7808 is discussed in Paragraph 5.2.2.

The above discussion of Figures 5-1 through 5-4 did not address the value of local ventilating velocity in the proximity of bleed ducts which could be lower than the average nacelle value. This observation no doubt crossed the reader's mind as the previous evaluation was discussed, because at average nacelle ventilating velocities less than six (6) feet per second, the general trend of MIT is toward lower values. For some run configurations, these values of MIT fall below the maximum bleed duct temperature and approach or equal values in the normal operating range of the engine for typical missions.

The OBSTRUCTIONS test configuration was specifically included in the test plan to investigate distorted ventilating flow and/or "dead air" regions. (To refresh details of this test configuration, refer to Figures 3-2, 3-3, and 3-4.) Results for this test configuration were somewhat different than anticipated.

Recall that the OBSTRUCTIONS test configuration was derived from the DUCT/CLAMP test configuration by adding the "obstructions". The results of investigating distorted ventilating flow and/or "dead air" regions is achieved by comparing these two test configurations for the same fluid injection method (drip).

For MIL-H-5606, this comparison is shown by Figure 5-1. Note the bucket in MIT values for the DUCT/CLAMP data with the minimum (approximately 650 $^{\circ}$F) occurring at a ventilating velocity of one and one-half (1.5) feet per second. It was anticipated the OBSTRUCTIONS configuration MIT results would be shifted to the right, as a function of average nacelle velocity illustrated below.




This anticipation was based on the thought a lower local "effective" velocity would exist at the hot duct surface causing MIT values similar to the configuration without obstructions but at higher average ventilating velocities. This shift would depend on how much the average nacelle ventilating velocity was blocked or obstructed. But, as previously noted, the results for the OBSTRUCTIONS test configuration were somewhat different than anticipated because the shift **DID NOT** occur to any significant extent for any of the fluids.

In fact, still referring to Figure 5-1 for MIL-H-5606, the MIT's for the OBSTRUCTIONS test configuration were higher than those of the DUCT/CLAMP for values of average ventilating velocity up to approximately six and one-half (6.5) feet per second. (As a precaution, additional data at ten (10) feet per second ventilating velocity was obtained for the OBSTRUCTIONS test configuration.)

The anticipated shift for the OBSTRUCTIONS test configuration did occur to a small extent with JP-4 as shown by Figure 5-2; however, it was observed only at low average ventilating velocities and was non existant at four (4) feet per second and above.

Both the DUCT/CLAMP and OBSTRUCTIONS test configurations with MIL-H-83282 drip injection have been identified as susceptible to ignition (6.0 fps and 1025 $^{\circ}$F evaluation criteria). Evaluating the effect of the obstructions with MIL-H-83282, Figure 5-3, it is noted the results are similar to MIL-H-5606, in that there was not a significant shift to the right in MIT values. The MIT's for the OBSTRUCTIONS test configuration are again higher than those of the DUCT/CLAMP up to an average ventilating velocity of approximately three and one-half (3.5) feet per second where they cross and become essentially parallel to the DUCT/CLAMP values but twenty-five (25) degrees less.

A possible limitation of this test was the number of configurations to simulate distorted or blocked ventilating velocity. The OBSTRUCTIONS configuration represented only one of many possibilities. The ever-present question of local velocities less than the six (6) feet per second minimum for the F-16 nacelle is partially addressed by Table 5-1. This table summarizes the minimum "safe" (MIT greater than 1025 $^{\circ}$F) local velocity for each run configuration. It DOES NOT consider the lower local velocities as necessarily being caused by "obstructions" and it is LIMITED to these lower local velocities being perpendicular to the bleed duct.

### 5.2.2 Results For a Given Test Configuration and Injection Method

In the previous paragraph, run configurations <u>susceptible</u> to ignition (ie, ignition at 1025 $^{\circ}$F and below) in the F-16 nacelle environment were identified. No mention was made of the remaining run configurations on those figures relative to <u>non-susceptibility</u> of ignition. Figures 5-5 through 5-9 compare the MIT's for each test configuration and method of fluid injection with the fluid

TABLE 5-1

MINIMUM SAFE LOCAL VELOCITIES

| RUN CONFIGURATION | | | MINIMUM SAFE* VELOCITY (ft/sec) | REFERENCE FIGURE NUMBER |
|---|---|---|---|---|
| TEST CONFIGURATION | INJECTION METHOD | FLUID | | |
| BARE DUCT | SPRAY | JP-4 | 0. | 5-5 |
| | | MIL-L-7808 | 2. | 5-5 |
| | | MIL-H-5606 | 2. | 5-5 |
| | | MIL-H-83282 | 3.5 | 5-5 |
| | DRIP | JP-4 | 0. | 5-6 |
| | | MIL-L-7808 | 0. | 5-6 |
| | | MIL-H-5606 | 2.5 | 5-6 |
| | | MIL-H-83282 | 1.5 | 5-6 |
| DUCT/CLAMP | SPRAY | JP-4 | 0. | 5-7 |
| | | MIL-H-5606 | 3.0 | 5-7 |
| | | MIL-H-83282 | 5.5 | 5-7 |
| | DRIP | JP-4 | 3.5 | 5-8 |
| | | MIL-H-5606 | 6.0 | 5-8 |
| | | MIL-H-83282 | >8. | 5-8 |
| OBSTRUCTIONS | DRIP | JP-4 | 3.5 | 5-9 |
| | | MIL-H-5606 | 5.5 | 5-9 |
| | | MIL-H-83282 | >8. | 5-9 |

* MIT $\geq$ 1025 $^{o}$F

used being the variable for each figure. This rearranged presentation of the MIT results more clearly illustrates the test configurations and types of leaks (method of fluid injection) that are not susceptible to ignition and by what margin. Those run configurations susceptible to ignition are also illustrated from a different perspective.

Figure 5-5 compares the MIT's for the BARE DUCT test configuration for all fluids with spray injection. The temperature margin for ignition (MIT minus 1025), considering all fluids, is greater than 200 degrees. Similarly for all fluids using drip injection, Figure 5-6 shows a temperature margin for ignition of 175 degrees. Thus the BARE DUCT test configuration is shown NOT to be susceptible to ignition in the F-16 nacelle environment for the fluids and injection methods considered in the study.

Figure 5-5 and 5-6 also serve to compare the test results of MIL-L-7808 to both MIL-H-5606 and JP-4 relative to continued testing of MIL-L-7808.

At the request of the cognizant engineering representative of the F-16 System Program Office, MIL-L-7808 was added to the study. To minimize additional facility occupancy time and overall impact on the study contract, the following agreement was reached.

If the MIT's of MIL-L-7808 for the initial test configuration and both fluid injection methods were:

- No lower than those of either MIL-H-5606 or JP-4 or

- Bracketed by those of MIL-H-5606 and JP-4 and/or

- Exhibited similar trends to either MIL-H-5606 or JP-4

then no further testing would be requested.

Review of Figures 5-5 and 5-6 show the above guidelines/criteria were satisfied.

Figure 5-7 shows the ignition temperature margin of JP-4, MIL-H-5606, and MIL-H-83282 for the DUCT/CLAMP test configuration with spray injection. MIL-H-83282 has the least margin, twenty-five (25) degrees, whereas the margin for MIL-H-5606 and JP-4 is three hundred (300) degrees or greater.

The ignition temperature margin with drip injection for the above test configuration and fluids is shown by Figure 5-8. MIL-H-83282, previously identified as susceptible to ignition for this test configuration and fluid injection method, has a negative margin of fifty (50) degrees (975 minus 1025). MIL-H-5606 has a zero margin, ie, the MIT is equal to but not less than 1025 °F.

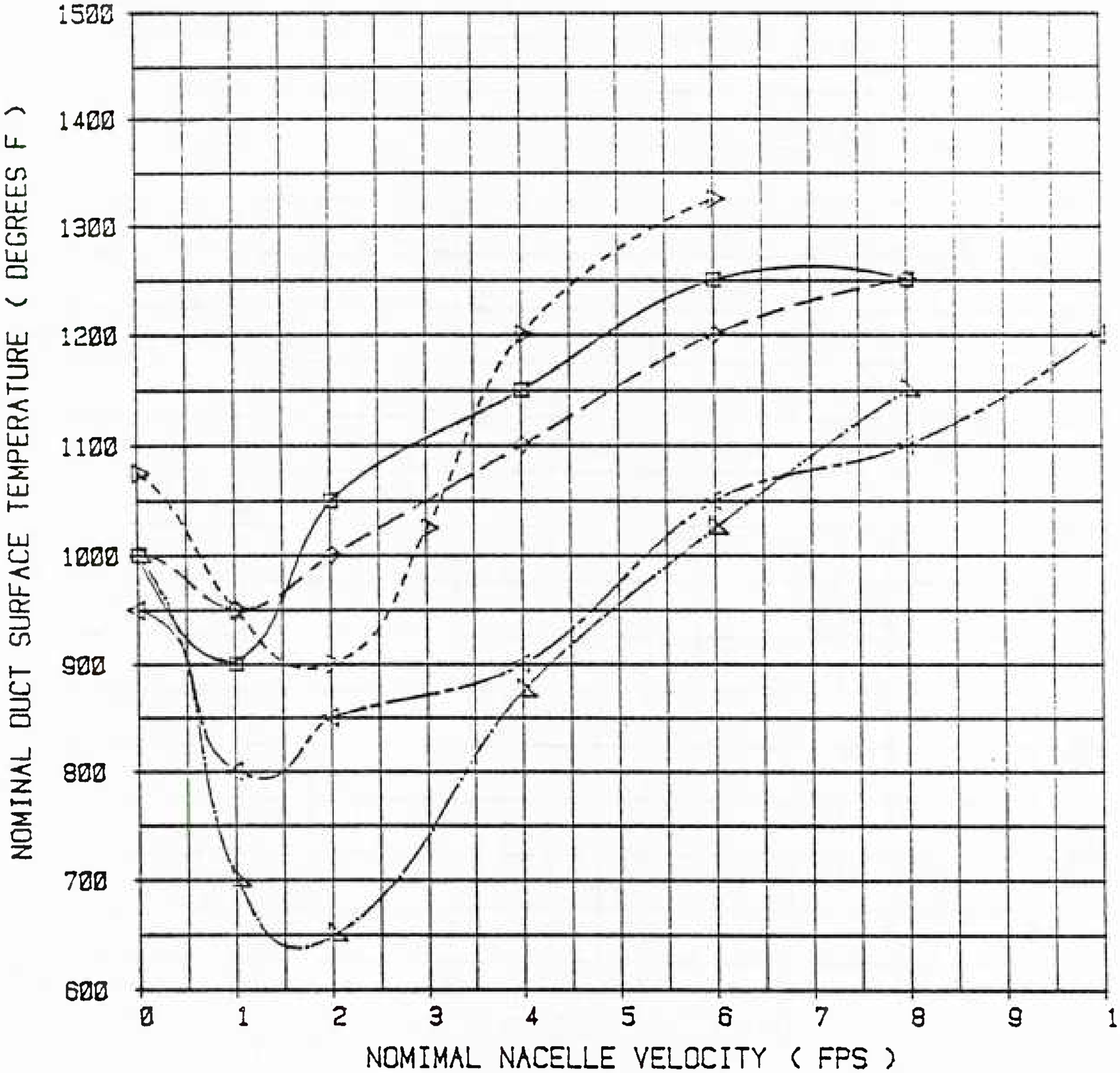
Figure 5-9 presents the MIT data for the three (3) fluids and the OBSTRUCTIONS test configuration with drip injection. MIL-H-83282, previously identified as susceptible to ignition for this test configuration and fluid injection method, has a negative ignition temperature margin of seventy-five (75) degrees. The margin for MIL-H-5606 and JP-4 is twenty-five (25) and seventy-five (75) degrees respectively.

### 5.2.3 Results For a Given Test Configuration and Fluid

Figures 5-10 through 5-15 more clearly illustrate the effect of the method of injection than the same data presentation in Figures 5-1 through 5-3. (See Figure 5-4 for comparison on MIL-L-7808.) Each figure compares the MIT's of spray and drip injection for one fluid and test configuration. Drip injection results in a lower MIT (at the evaluation point) with the exception of JP-4 (Figure 5-12) and MIL-L-7808 (Figure 5-16) on the BARE DUCT test configuration.

FIGURE 5-1

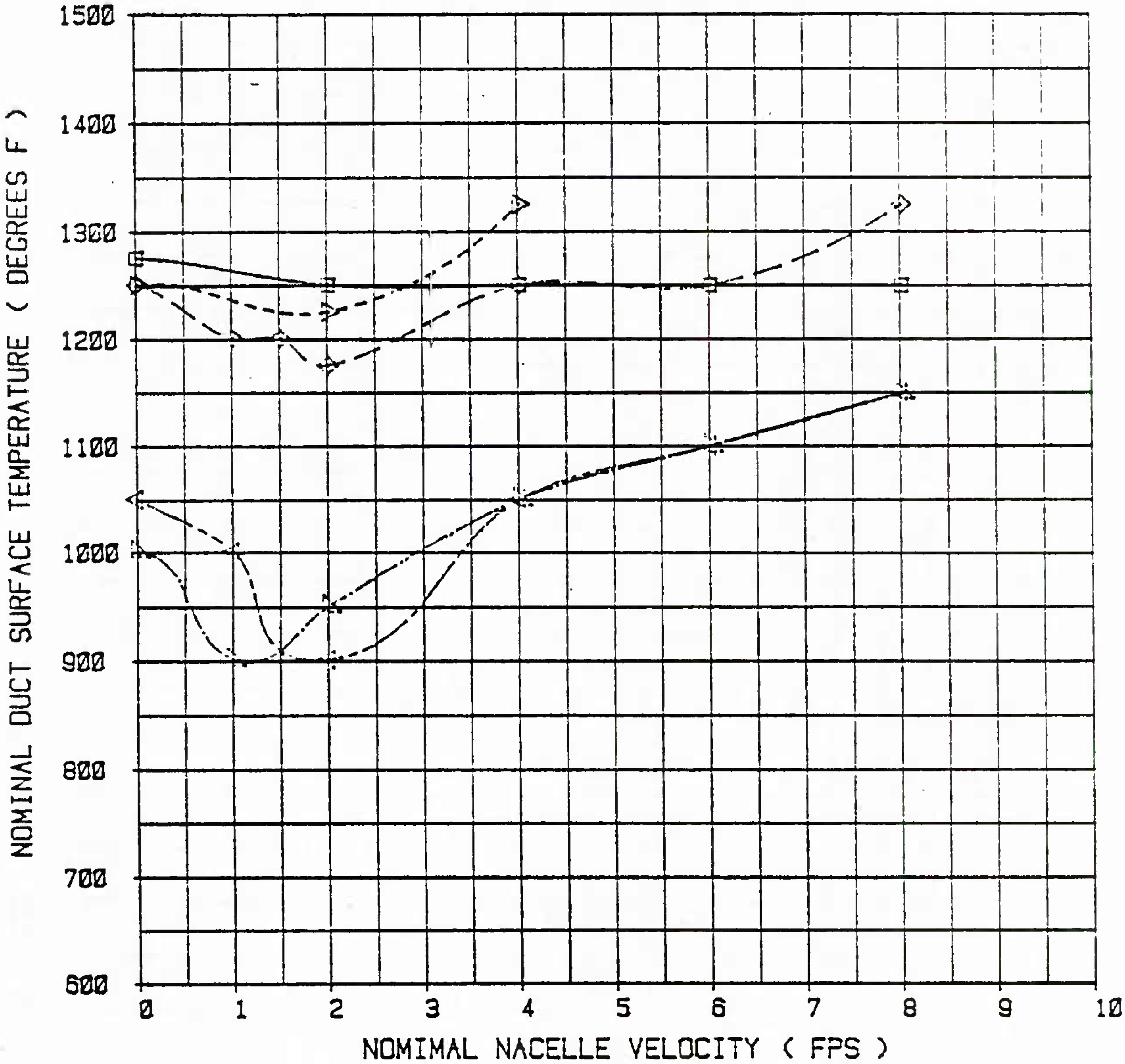
COMPARISON OF MINIMUM SPONTANEOUS IGNITION TEMPERATURES




| SYMBOL | FLUID | CONFIGURATION | INJ. METH. |
|---|---|---|---|
| ⊡ | MIL-H-5606 | BARE DUCT | SPRAY |
| ▷ | MIL-H-5606 | DUCT/CLAMP | SPRAY |
| ◇ | MIL-H-5606 | BARE DUCT | DRIP |
| △ | MIL-H-5606 | DUCT/CLAMP | DRIP |
| ◁ | MIL-H-5606 | OBSTRUCTIONS | DRIP |

FIGURE 5-2

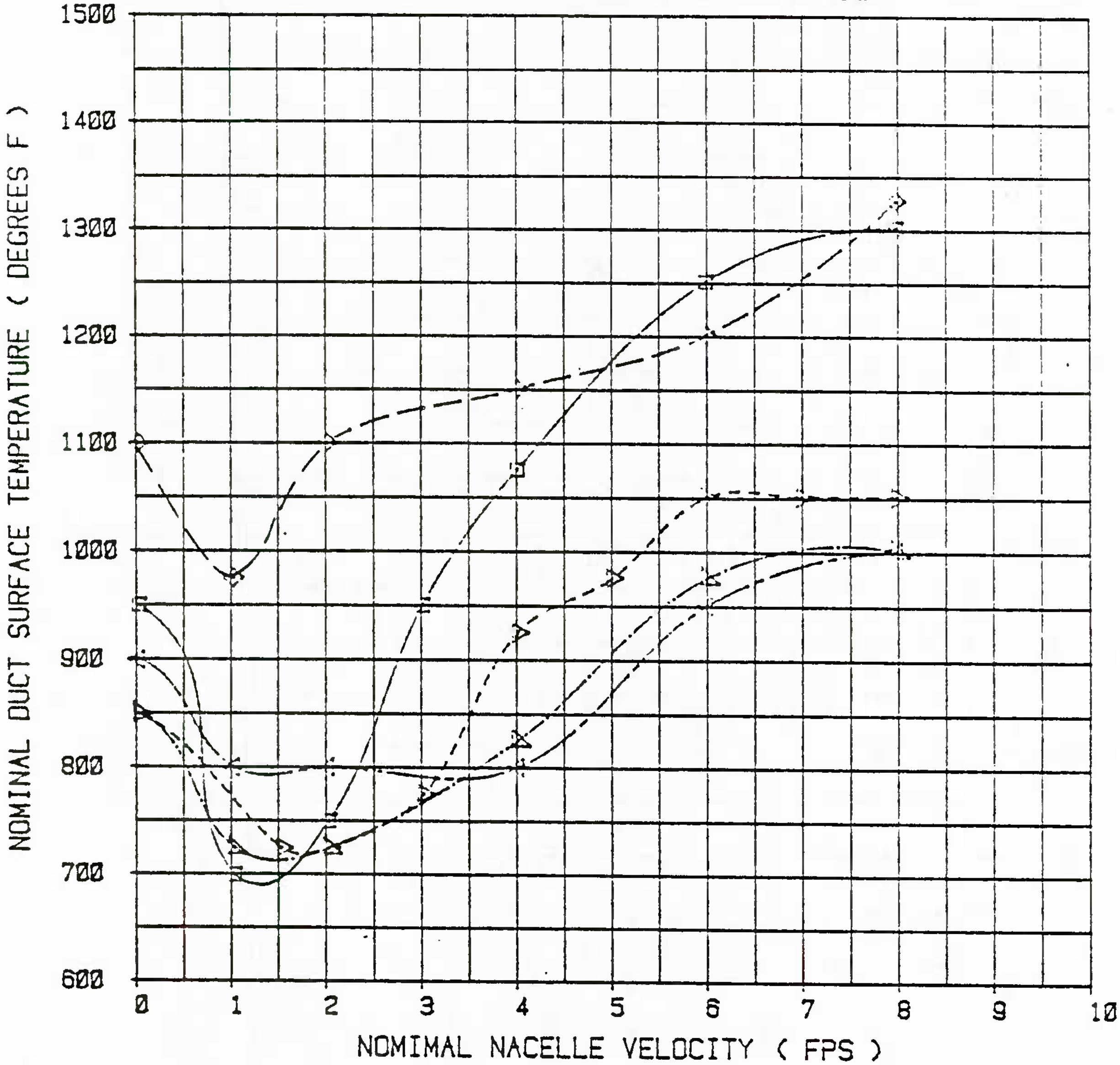
COMPARISON OF MINIMUM SPONTANEOUS IGNITION TEMPERATURES




| SYMBOL | FLUID | CONFIGURATION | INJ. METH. |
|---|---|---|---|
| ⊡ | JP-4 | BARE DUCT | SPRAY |
| ▷ | JP-4 | DUCT/CLAMP | SPRAY |
| ◇ | JP-4 | BARE DUCT | DRIP |
| ◺ | JP-4 | DUCT/CLAMP | DRIP |
| ◁ | JP-4 | OBSTRUCTIONS | DRIP |

FIGURE 5-3

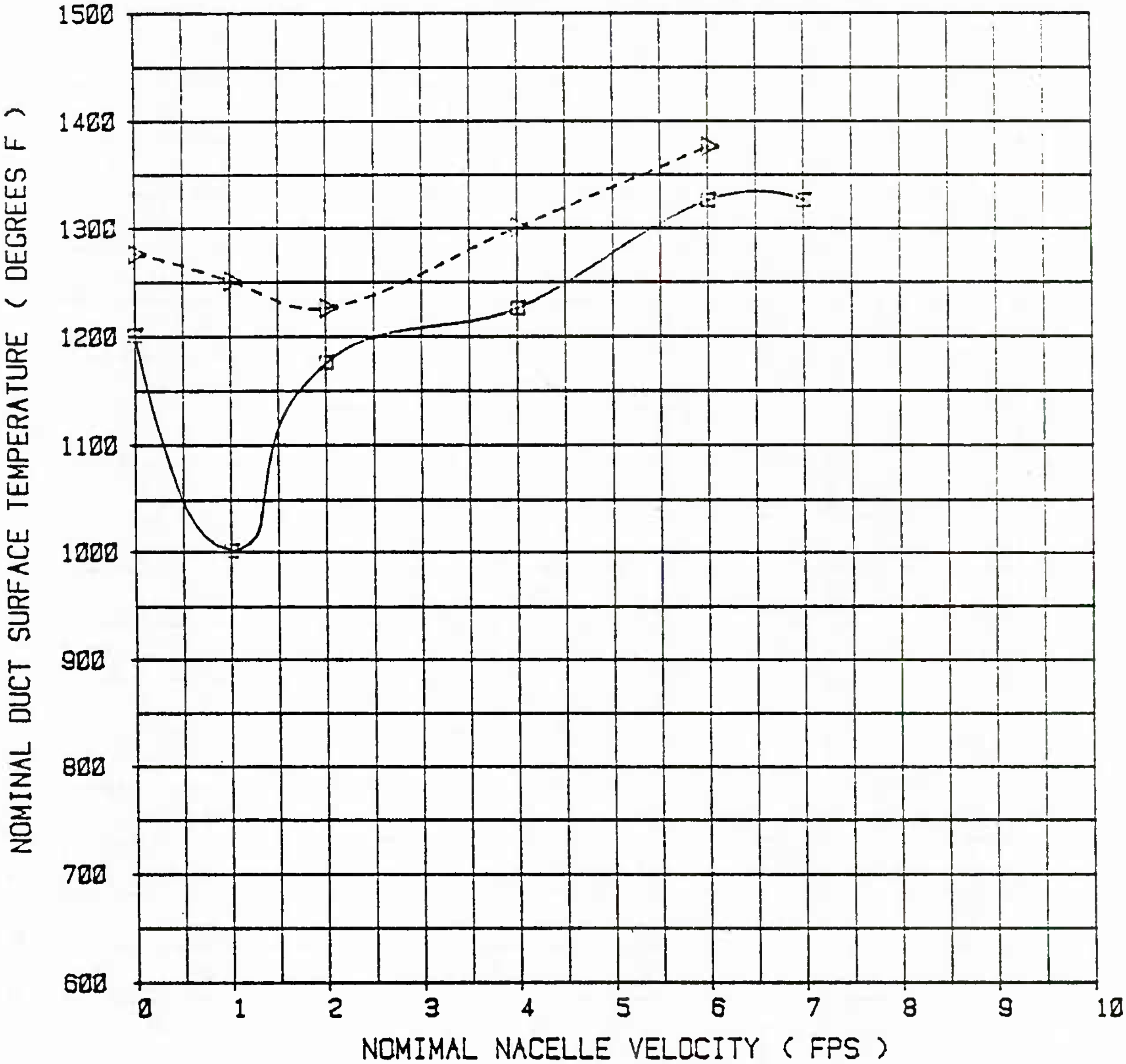
COMPARISON OF MINIMUM SPONTANEOUS IGNITION TEMPERATURES




| SYMBOL | FLUID | CONFIGURATION | INJ. METH. |
|---|---|---|---|
| ⊡ | MIL-H-83282 | BARE DUCT | SPRAY |
| ▷ | MIL-H-83282 | DUCT/CLAMP | SPRAY |
| ◇ | MIL-H-83282 | BARE DUCT | DRIP |
| ◺ | MIL-H-83282 | DUCT/CLAMP | DRIP |
| ◁ | MIL-H-83282 | OBSTRUCTIONS | DRIP |

FIGURE 5-4

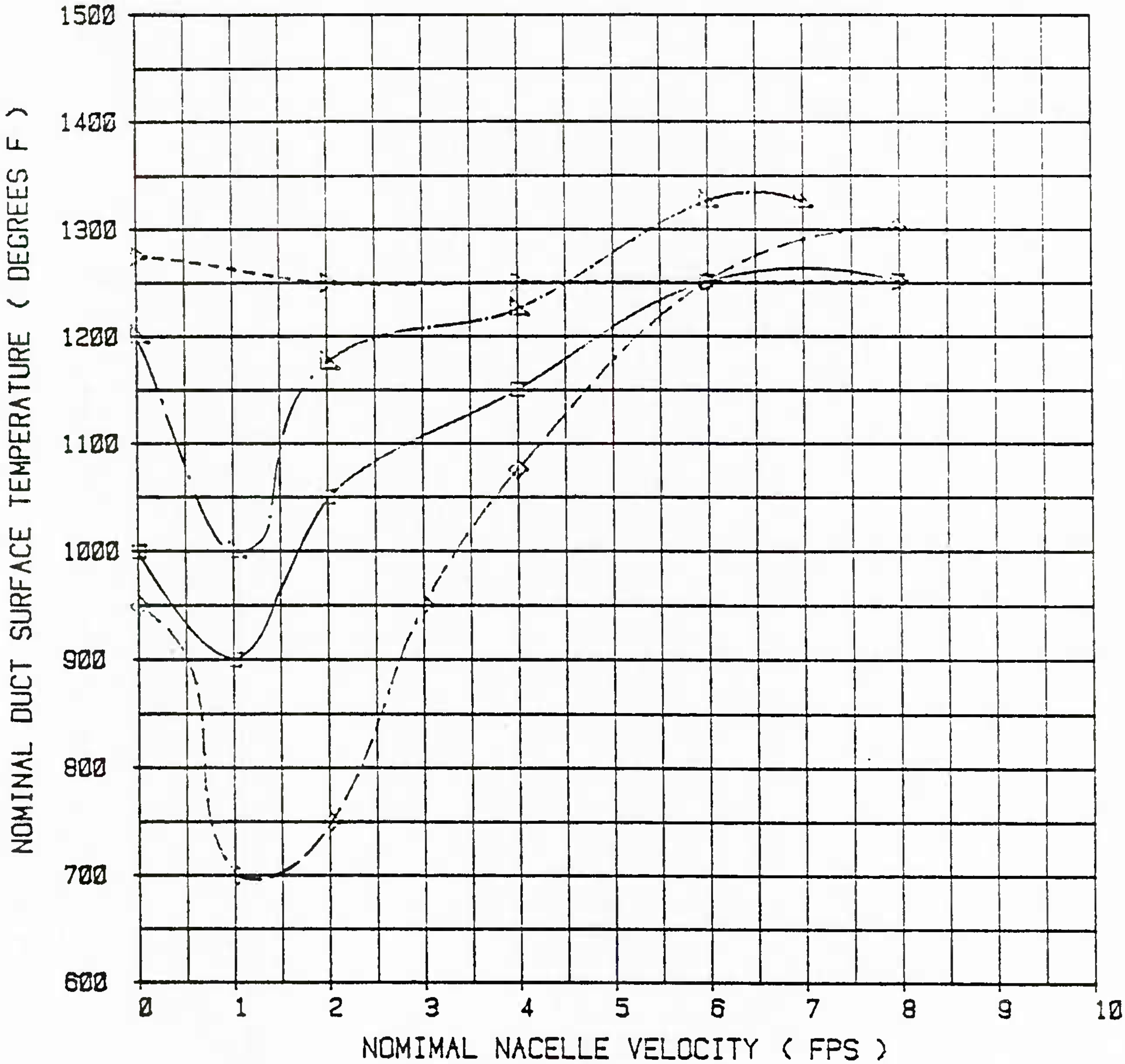
COMPARISON OF MINIMUM SPONTANEOUS IGNITION TEMPERATURES




| SYMBOL | FLUID | CONFIGURATION | INJ. METH. |
|---|---|---|---|
| ⊡ | MIL-L-7808 | BARE DUCT | SPRAY |
| ▷ | MIL-L-7808 | BARE DUCT | DRIP |

FIGURE 5-5

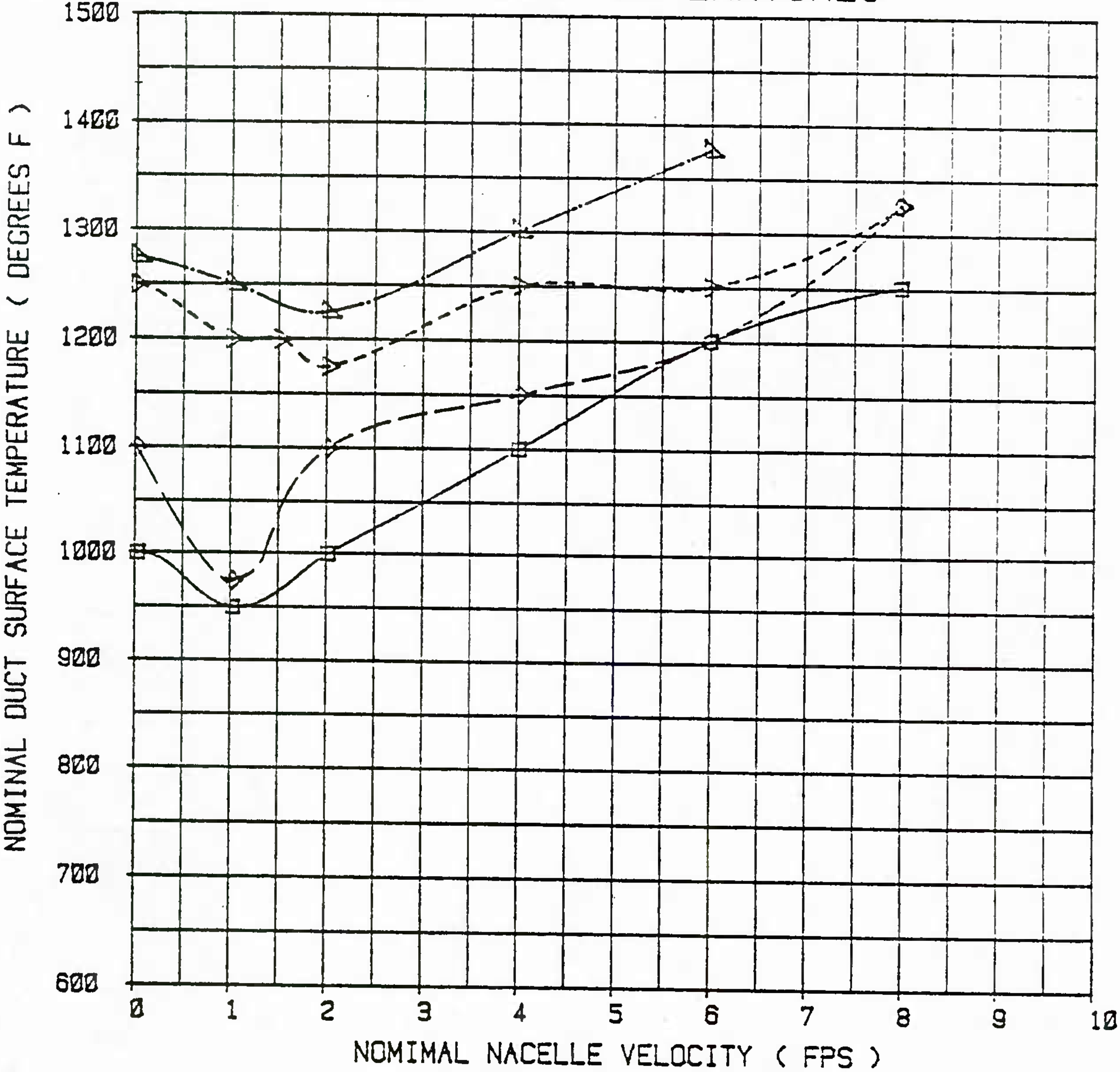
COMPARISON OF MINIMUM SPONTANEOUS IGNITION TEMPERATURES




| SYMBOL | FLUID | CONFIGURATION | INJ. METH. |
|---|---|---|---|
| ⊡ | MIL-H-5606 | BARE DUCT | SPRAY |
| ▷ | JP-4 | BARE DUCT | SPRAY |
| ◇ | MIL-H-83282 | BARE DUCT | SPRAY |
| ◺ | MIL-L-7808 | BARE DUCT | SPRAY |

FIGURE 5-6

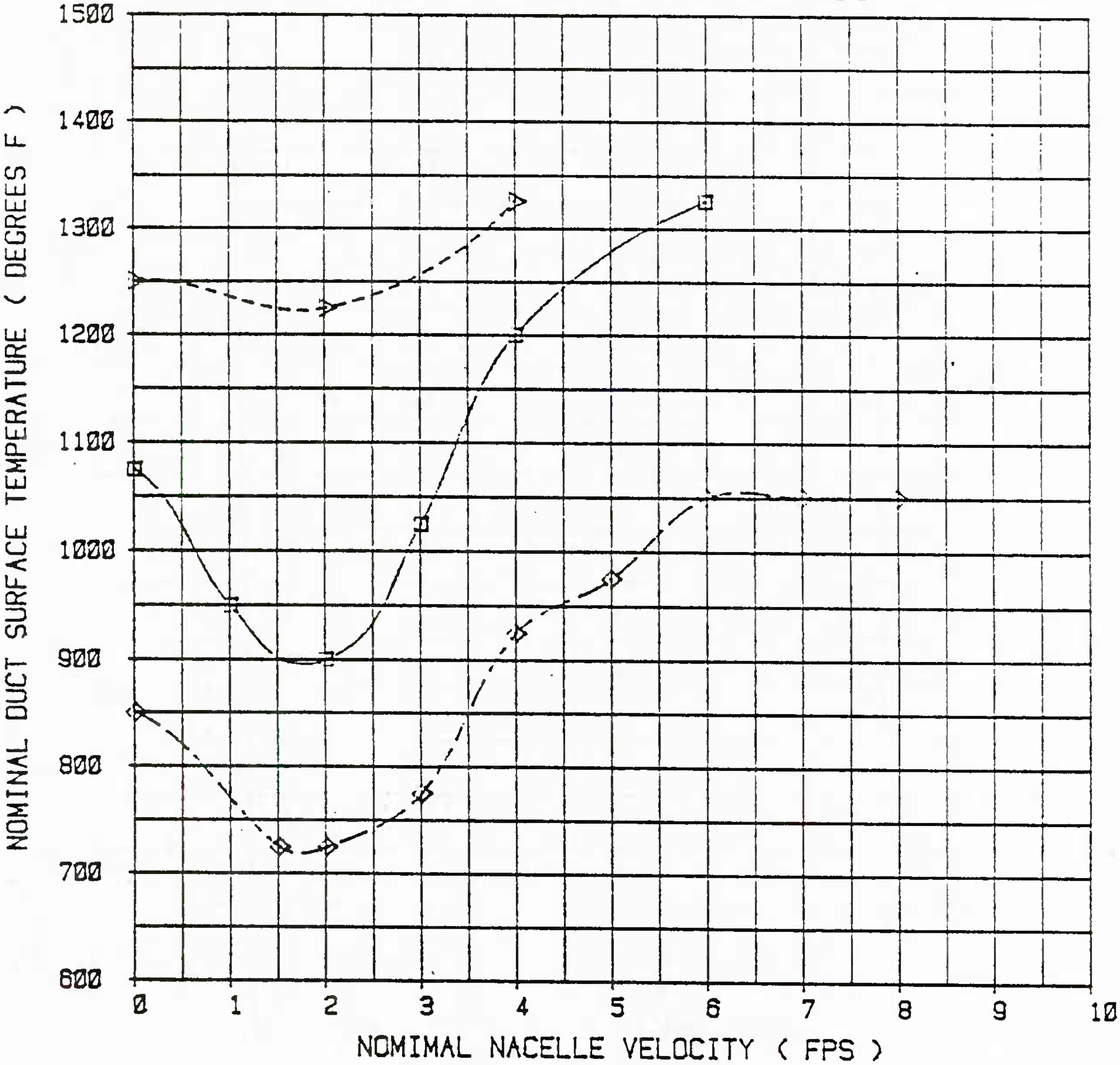
## COMPARISON OF MINIMUM SPONTANEOUS IGNITION TEMPERATURES




| SYMBOL | FLUID | CONFIGURATION | INJ. METH. |
|---|---|---|---|
| ⊡ | MIL-H-5606 | BARE DUCT | DRIP |
| ▷ | JP-4 | BARE DUCT | DRIP |
| ◇ | MIL-H-83282 | BARE DUCT | DRIP |
| ◺ | MIL-L-7808 | BARE DUCT | DRIP |

FIGURE 5-7

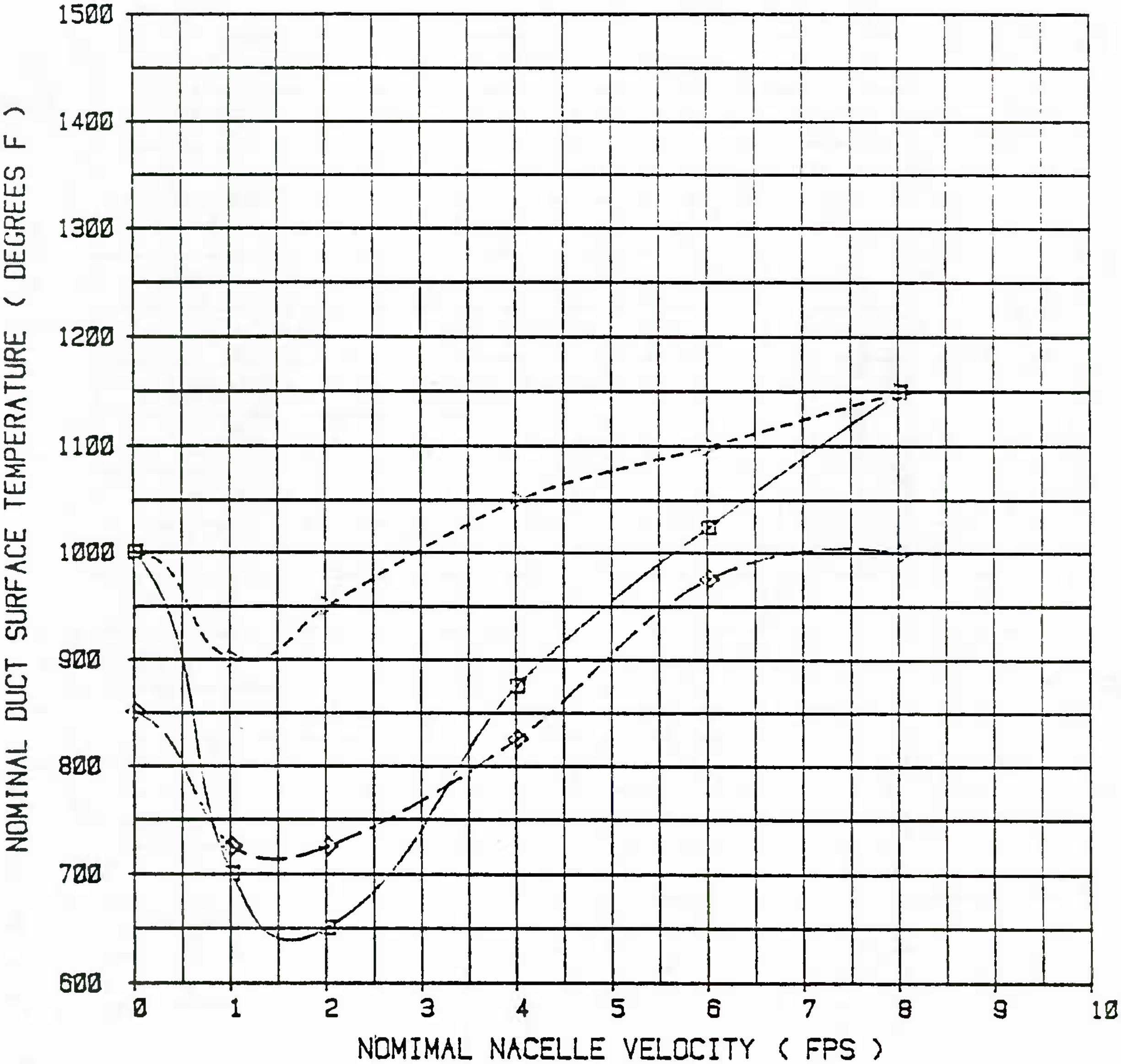
COMPARISON OF MINIMUM SPONTANEOUS IGNITION TEMPERATURES




| SYMBOL | FLUID | CONFIGURATION | INJ. METH. |
|---|---|---|---|
| ⊡ | MIL-H-5606 | DUCT/CLAMP | SPRAY |
| ▷ | JP-4 | DUCT/CLAMP | SPRAY |
| ◇ | MIL-H-83282 | DUCT/CLAMP | SPRAY |

FIGURE 5-8

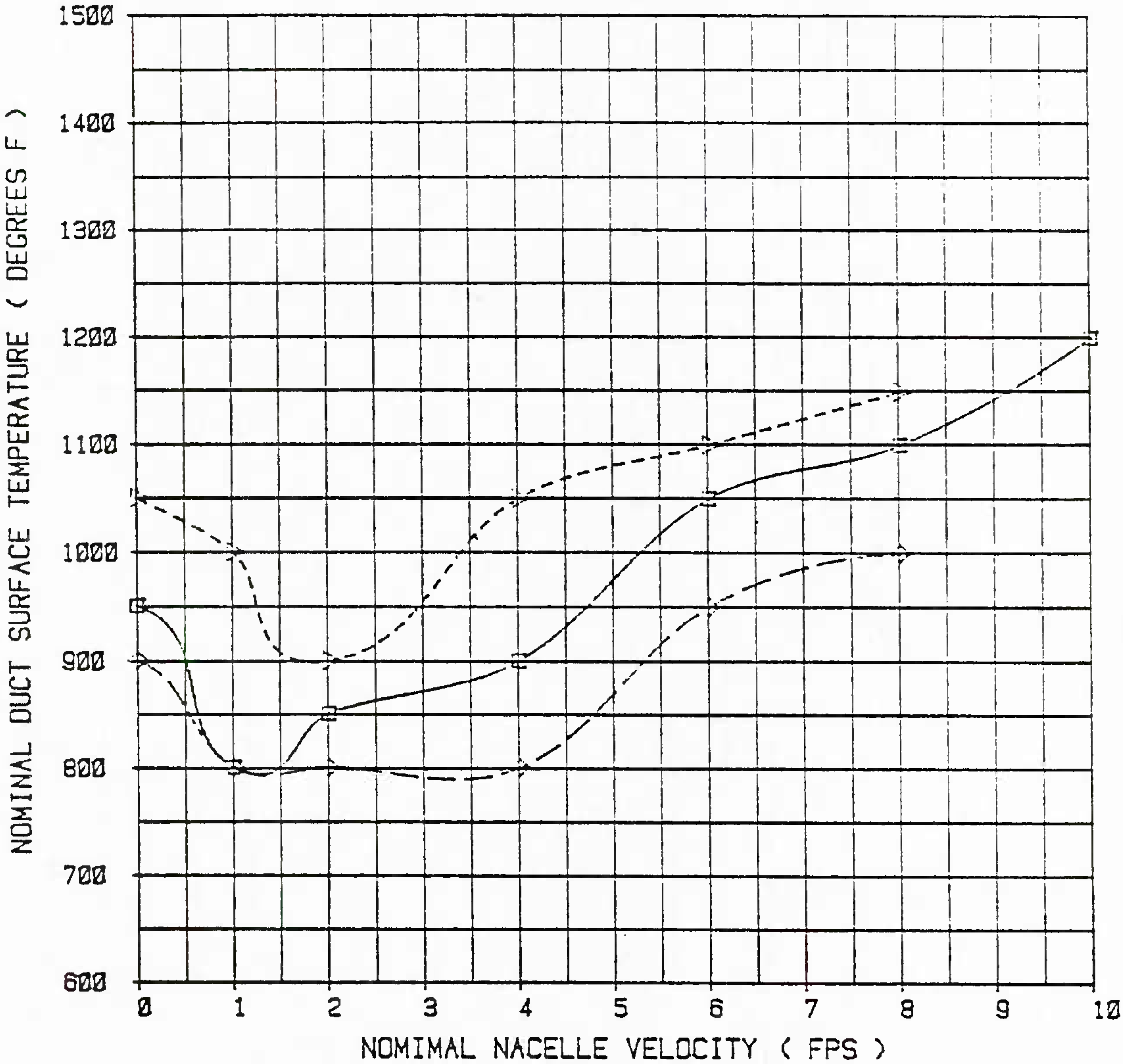
COMPARISON OF MINIMUM SPONTANEOUS IGNITION TEMPERATURES




| SYMBOL | FLUID | CONFIGURATION | INJ. METH. |
|---|---|---|---|
| □ | MIL-H-5606 | DUCT/CLAMP | DRIP |
| ▷ | JP-4 | DUCT/CLAMP | DRIP |
| ◇ | MIL-H-83282 | DUCT/CLAMP | DRIP |

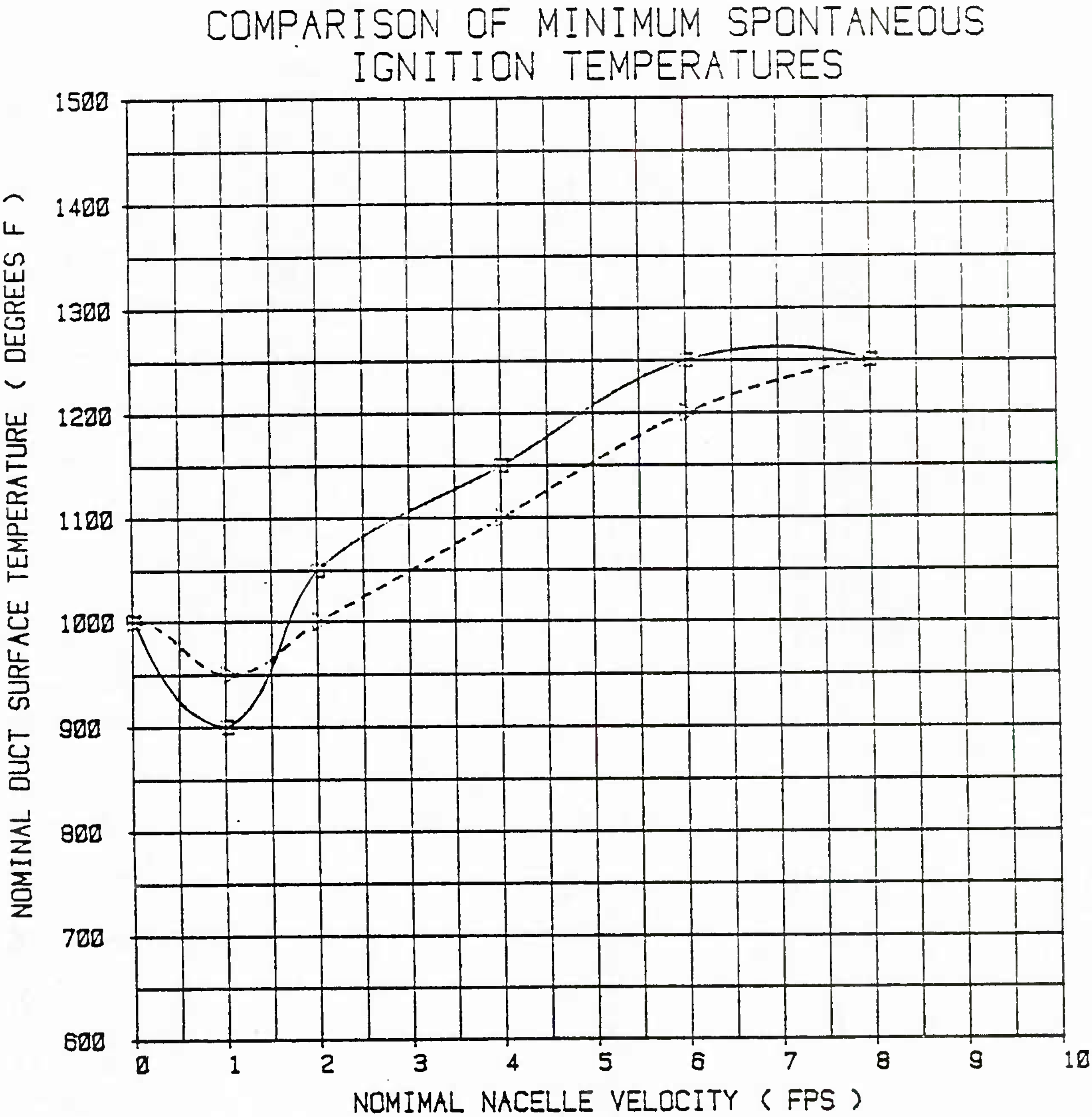
FIGURE 5-9

COMPARISON OF MINIMUM SPONTANEOUS IGNITION TEMPERATURES



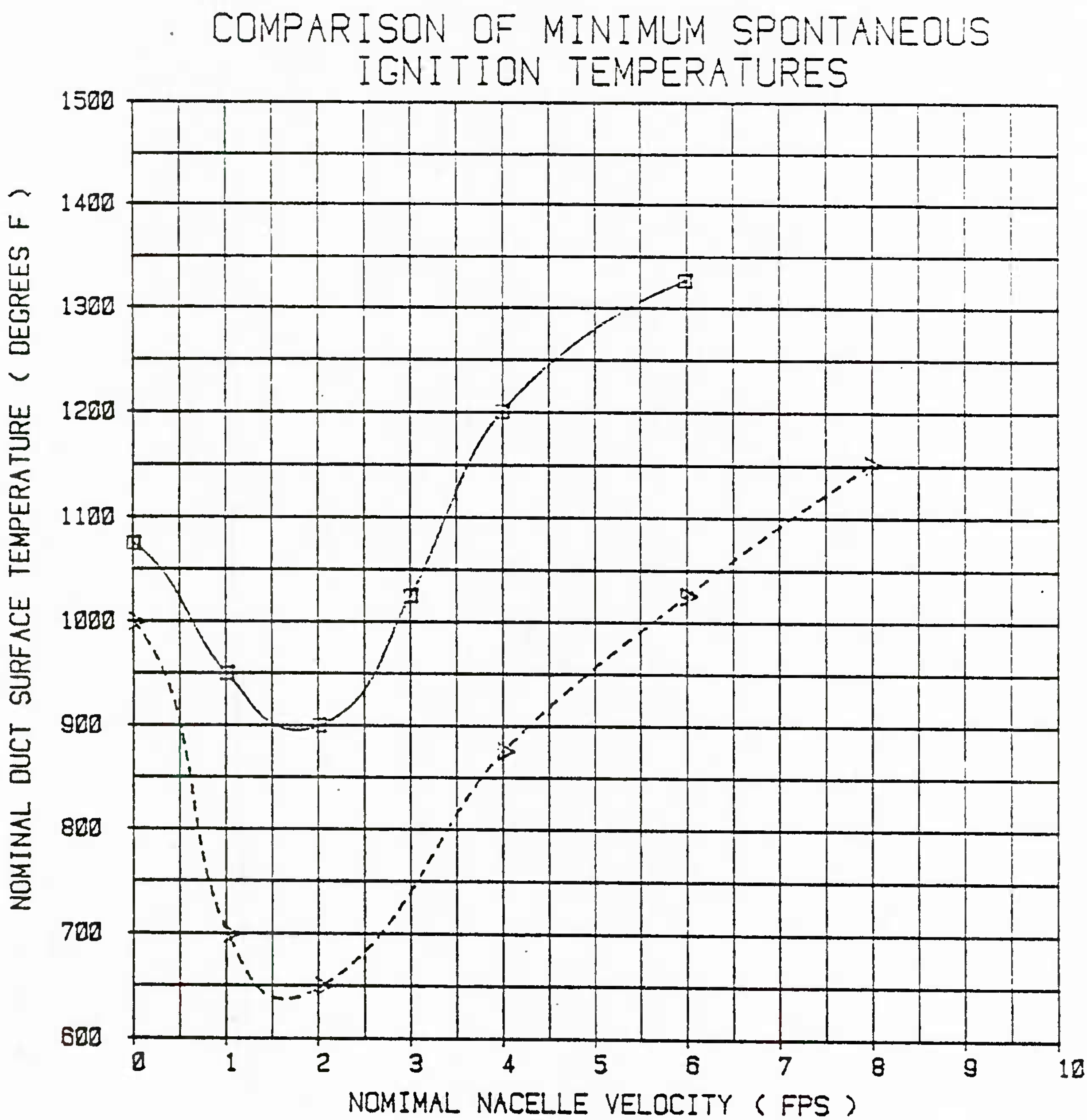

| SYMBOL | FLUID | CONFIGURATION | INJ. METH. |
|---|---|---|---|
| ⊡ | MIL-H-5606 | OBSTRUCTIONS | DRIP |
| ▷ | JP-4 | OBSTRUCTIONS | DRIP |
| ◇ | MIL-H-83282 | OBSTRUCTIONS | DRIP |

FIGURE 5-10




| SYMBOL | FLUID | CONFIGURATION | INJ. METH. |
|---|---|---|---|
| ⊡ | MIL-H-5606 | BARE DUCT | SPRAY |
| ▷ | MIL-H-5606 | BARE DUCT | DRIP |

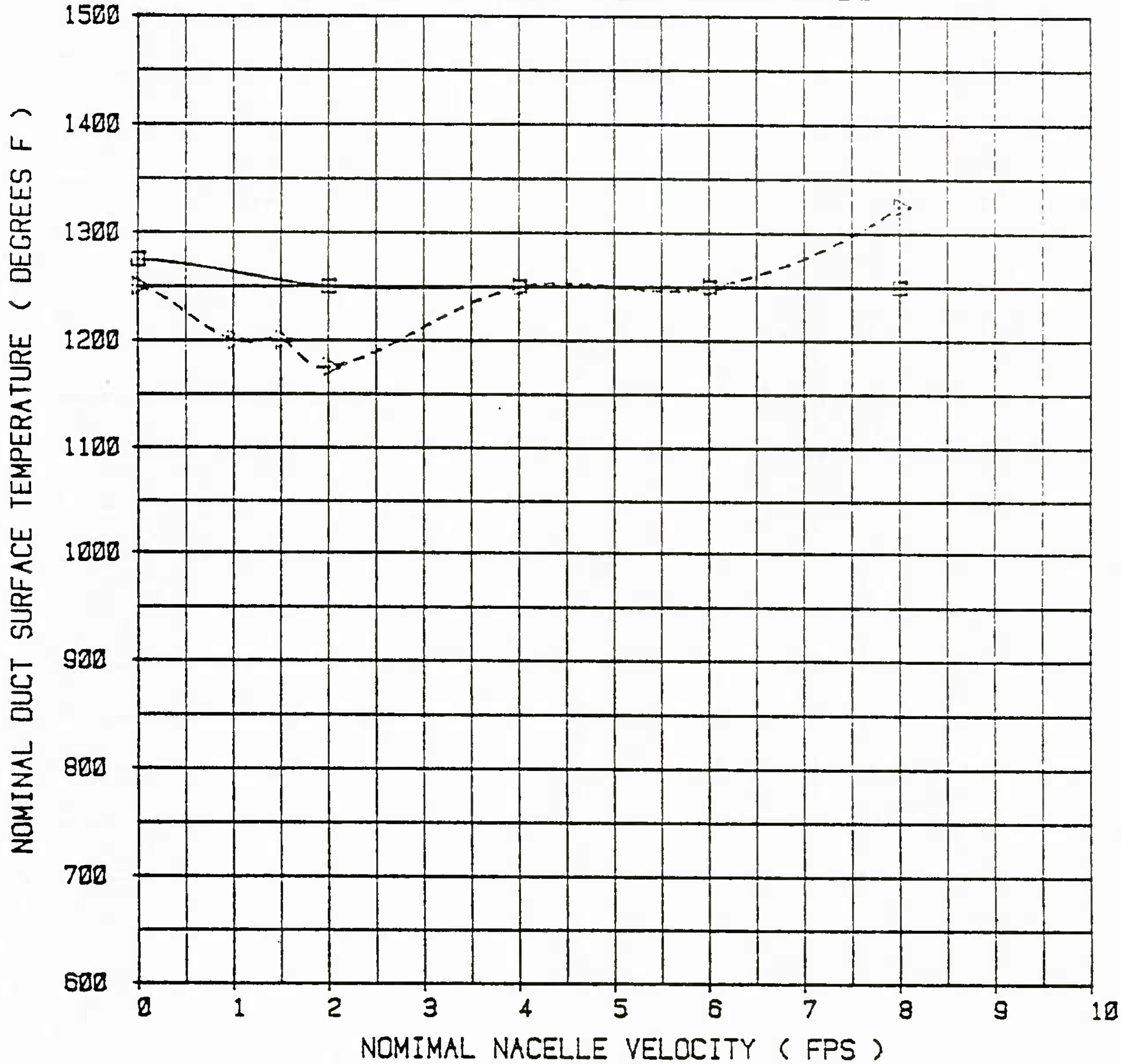
FIGURE 5-11




| SYMBOL | FLUID | CONFIGURATION | INJ. METH. |
|---|---|---|---|
| □ | MIL-H-5606 | DUCT/CLAMP | SPRAY |
| ▷ | MIL-H-5606 | DUCT/CLAMP | DRIP |

FIGURE 5-12

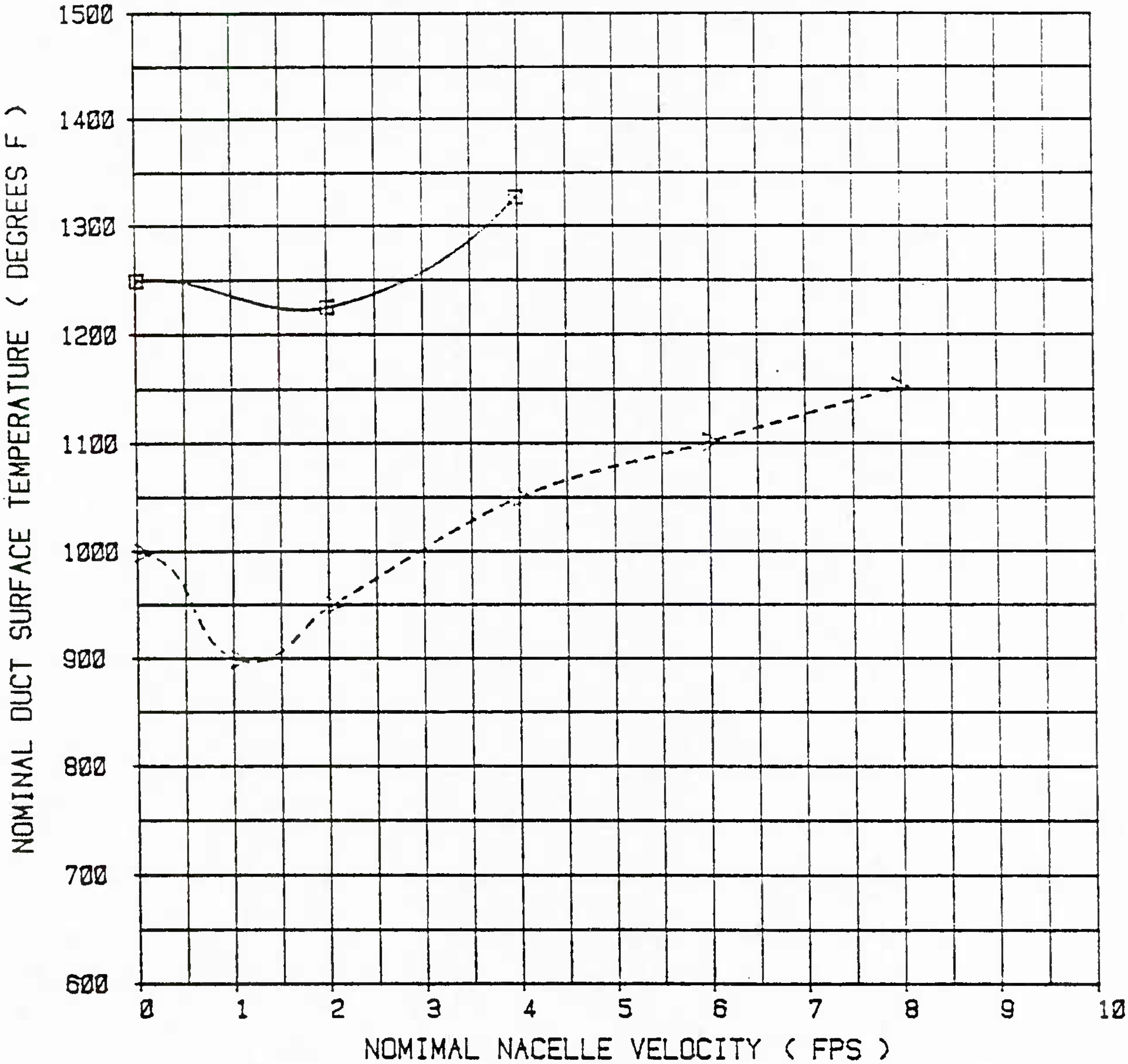
COMPARISON OF MINIMUM SPONTANEOUS IGNITION TEMPERATURES




| SYMBOL | FLUID | CONFIGURATION | INJ. METH. |
|---|---|---|---|
| ⊡ | JP-4 | BARE DUCT | SPRAY |
| ▷ | JP-4 | BARE DUCT | DRIP |

FIGURE 5-13

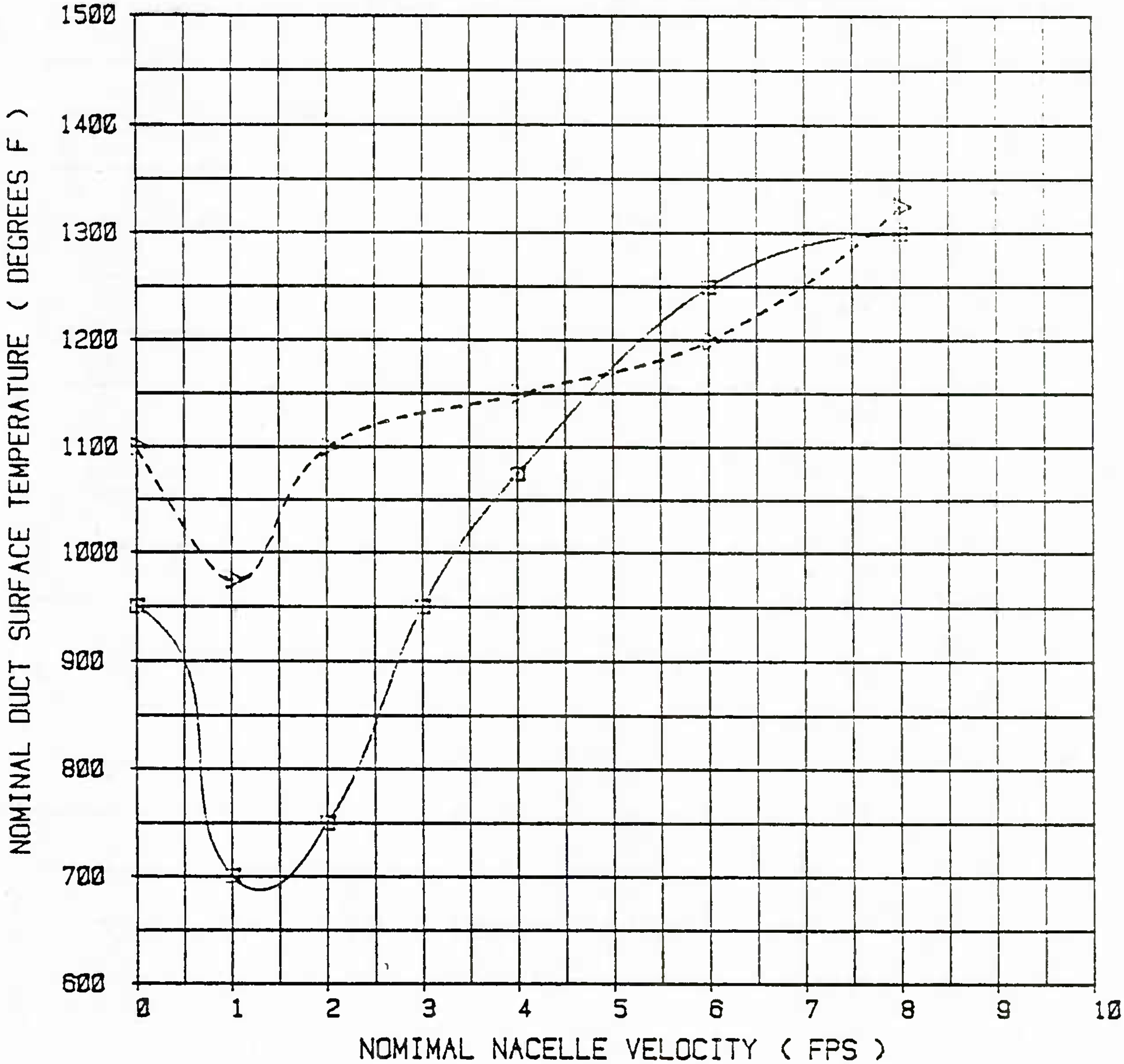
COMPARISON OF MINIMUM SPONTANEOUS IGNITION TEMPERATURES




| SYMBOL | FLUID | CONFIGURATION | INJ. METH. |
|---|---|---|---|
| ⊡ | JP-4 | DUCT/CLAMP | SPRAY |
| ▷ | JP-4 | DUCT/CLAMP | DRIP |

FIGURE 5-14

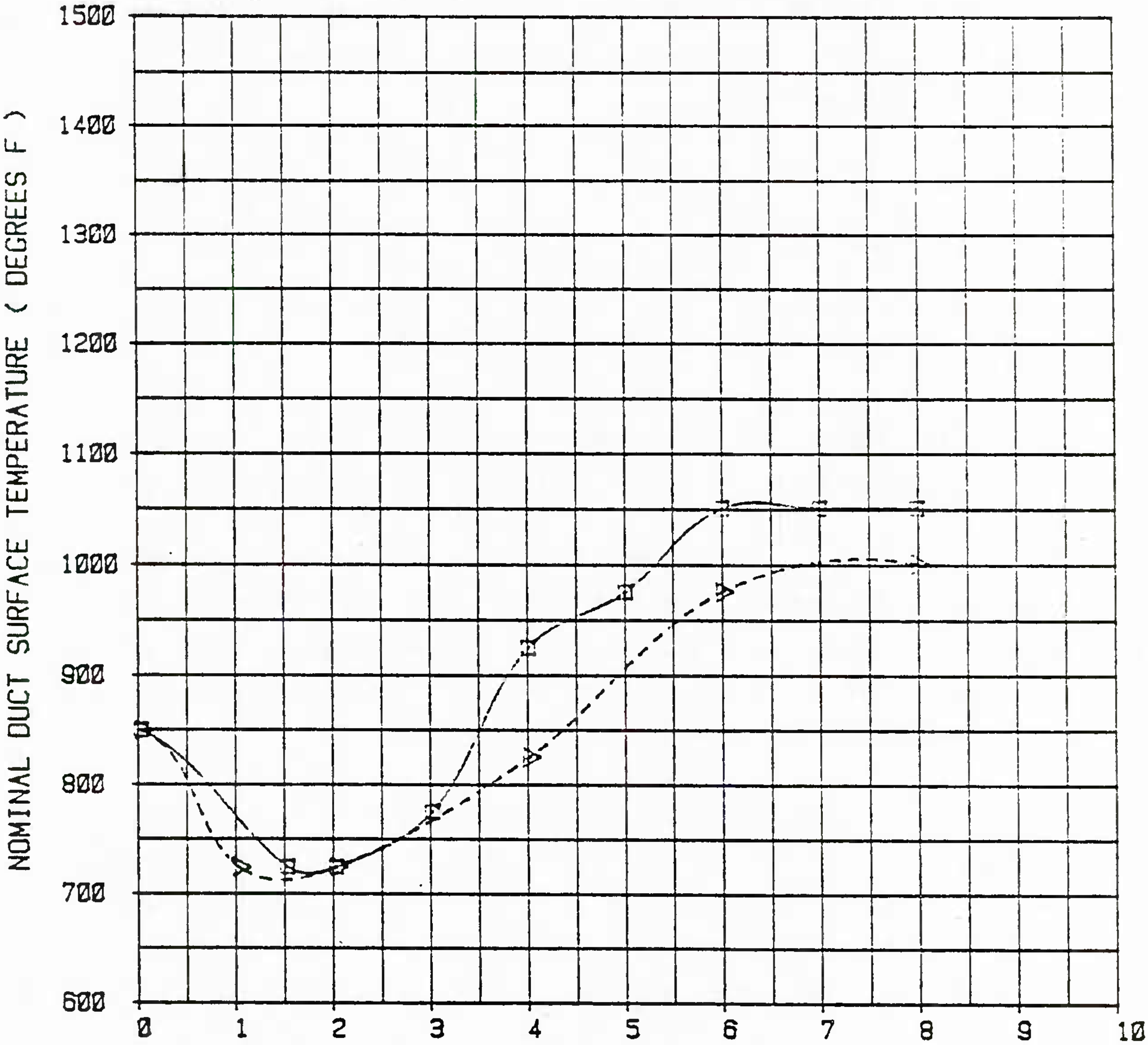
COMPARISON OF MINIMUM SPONTANEOUS IGNITION TEMPERATURES




| SYMBOL | FLUID | CONFIGURATION | INJ. METH. |
|---|---|---|---|
| ⊡ | MIL-H-83282 | BARE DUCT | SPRAY |
| ▷ | MIL-H-83282 | BARE DUCT | DRIP |

FIGURE 5-15

COMPARISON OF MINIMUM SPONTANEOUS IGNITION TEMPERATURES




| SYMBOL | FLUID | CONFIGURATION | INJ. METH. |
|---|---|---|---|
| ⊡ | MIL-H-83282 | DUCT/CLAMP | SPRAY |
| ▷ | MIL-H-83282 | DUCT/CLAMP | DRIP |

## 6 SUMMARY OF RESULTS AND CONCLUSIONS

The fluids tested are ranked in the following order relative to susceptibility to ignition caused by hot engine-bleed-air ducts in an F-16 ventilated nacelle.

. MIL-H-83282

. MIL-H-5606

. JP-4

. MIL-L-7808

This ranking is according to overall trends. There are exceptions for specific test configurations and methods of injection.

MIL-H-5606, JP-4, and MIL-L-7808 test results, all evaluated at 6 feet per second ventilating velocity, DO NOT exhibit an MIT (minimum ignition temperature) less than the maximum bleed-air duct temperature of 1025 degrees F for any test configuation or injection method.

MIL-H-83282 ,although not currently used in the F-16, is the most susceptible to ignition as noted above and the test results show two (2) test configurations with drip injection to have an MIT less than the 1025 degrees F maximum bleed-air duct temperature at six (6) feet per second ventilating velocity.

Results of the OBSTRUCTIONS test configuration, simulating distorted ventilating flow and/or "dead air" regions, DID NOT differ significantly from those of the test configuration without "obstructions".

The addition of the Cushion Loop Clamp to the BARE DUCT test configuration significantly enhanced ignition and generally lowered the value of the temperature of the bleed duct that would cause ignition.

In general, drip fuel injection results in a lower MIT (at the evaluation point). Two (2) exceptions are for the BARE DUCT test configuration using JP-4 (no difference) and MIL-L-7808 (fifty degrees higher).

## REFERENCES


1. Design Handbook Series 2-0 Aeronautical Systems, AFSC DH 2-3 PROPULSION AND POWER

2. MIL-E-38453, General Specification for Environmental Control, Environmental Protection and Engine Bleed Air Systems, Aircraft and Air Launched Missiles

3. Rinaldo, F. R.; Fault Tree Analysis For Uninsulated F-100 Engine Bleed Air Line; General Dunamics Report: 16PR2651; Publication Date TBD

4. AFWAL-TR-80-2055; Aircraft Engine Nacelle Fire Test Simulator; Volume I, Technical; May 1980

5. Zielke, D. G.; Dunkelberg, S. B.; Flight Test Report on F-16 Nacelle Ventilation System; General Dynamics Report; 16PR1244; 30 July, 1979.

# APPENDICES

PAGE

APPENDICES

Appendix I

# FLUID INJECTION CALIBRATION

## I.1 Nozzle Identification

The three digit nozzle nomenclature defines the nozzle in the following manner.

```
X XX
|  └── Orifice diameter (thousandths)
└───── Spray fan half-width one (1) foot
       from orifice (inches)
```

## I.2 Spray Calibration

Two nozzles, 621 and 513, were calibrated for MIL-H-5606 and JP-4. Flow rate VS reservior pressure is shown by Figure I-1. Nozzle 621 was calibrated for MIL-H-83282 and MIL-L-7808. The results are presented by Figure A-2.

## I.3 Drip Calibration

The drip injection system calibration is shown by Figure I-3. Note the flow rate is a function of the micro valve setting (refer to Figure 3-6) for a constant reservior pressure of 100 psig.

FIGURE I-1

COMBUSTIBLE INJECTION CALIBRATION

JP-4 AND MIL-H-5606 SPRAY

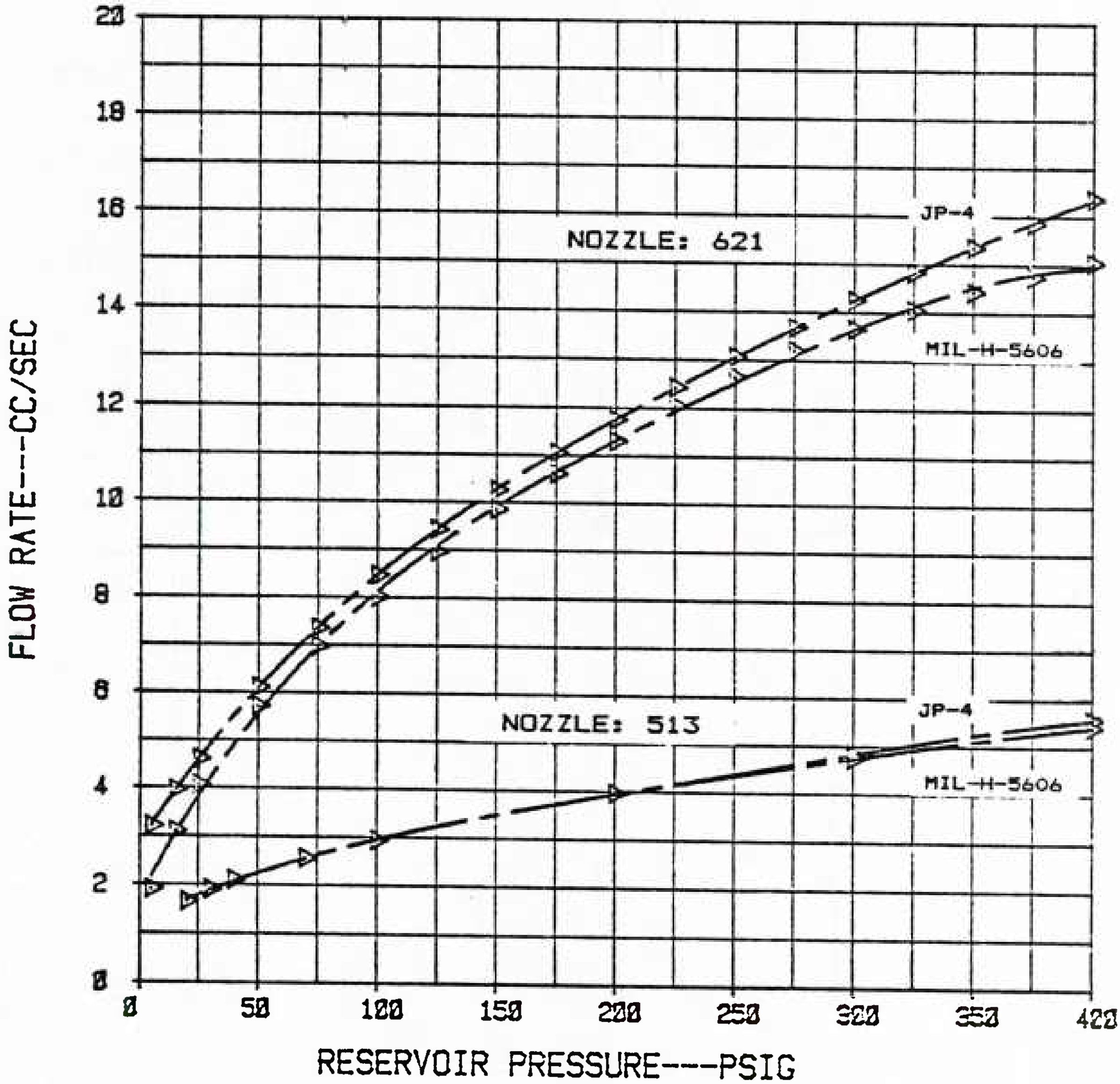


FIGURE I-2

COMBUSTIBLE INJECTION CALIBRATION

MIL-H-83282 AND MIL-L-7808 SPRAY

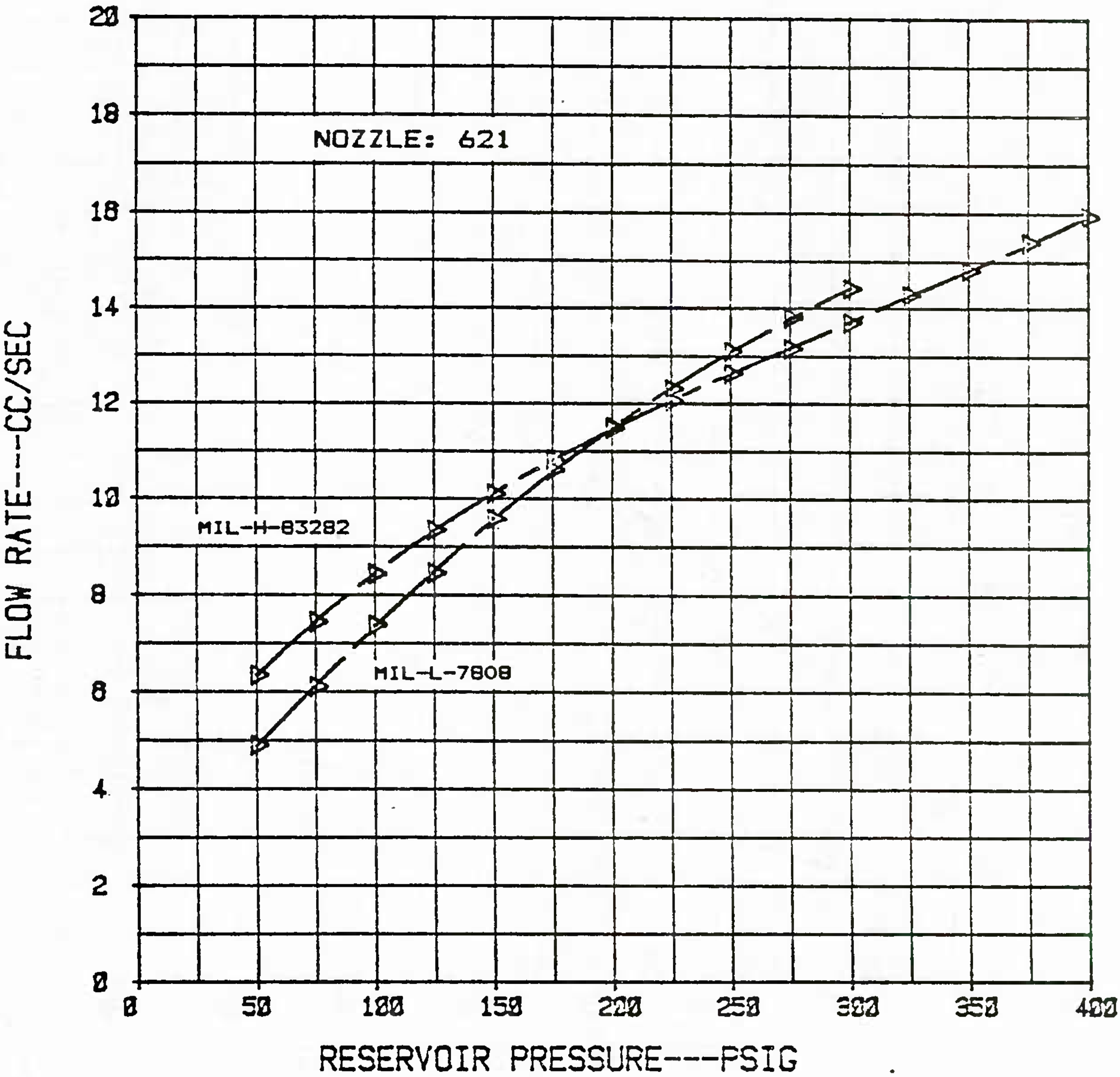
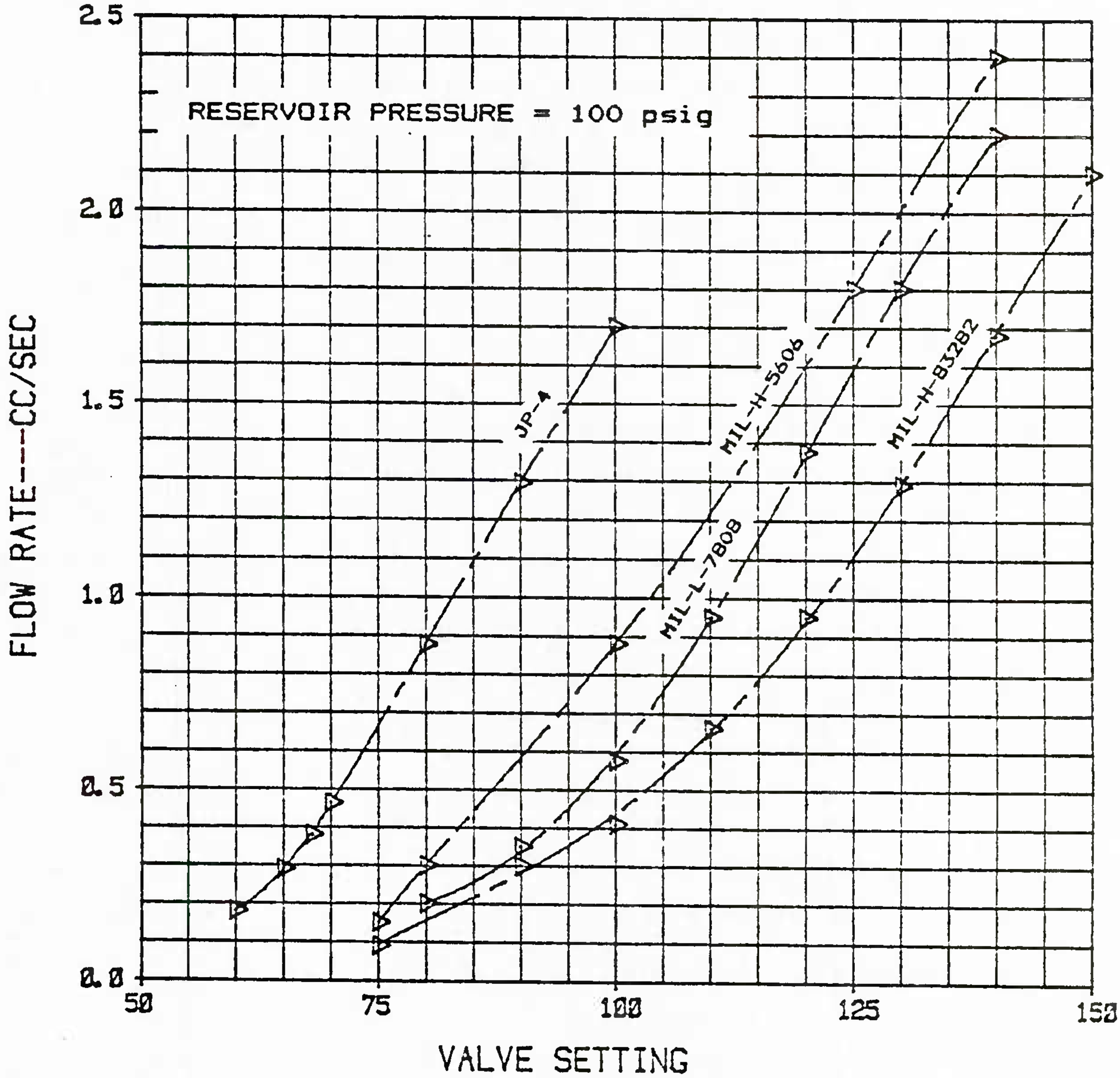


FIGURE I-3

COMBUSTIBLE INJECTION CALIBRATION

DRIP---ALL LIQUIDS



## Appendix II

### DETAILED SET-UP AND PRE-RUN PROCEDURES

To establish a run configuration, the following procedures formed an informal check list for a given test configuration (BARE DUCT, DUCT/CLAMP, OBSTRUCTIONS).

A. Fluid injection system

1. Filters cleaned
2. Lines purged of previous fluid
3. Correct lines connected for injection method to be used.
4. Fluid reservoir serviced with fluid to be used.
5. Fluid pressure set for desired flow rate (spray).
6. Fluid pressure and micro valve set for desired flow rate (drip).
7. Activate injection to fill lines

B. Other

1. Viewing window cleaned
2. UV detector and "back light" window cleaned.
3. Heater power connected
4. Run configuration and data point number input to data system.
5. Facility Safety Check List complete.
6. Remote TV and tape machine operational.
7. Power heaters to check thermocouple connections, digital indicators, and on-line data.
8. Establish desired test section velocity (nacelle ventilating velocity) and inlet temperature.
9. Injection time program set for desired cut-off time.
10. Set the temperature controller to obtain a duct temperature of 1300 - 1350 $^{o}$F using T/C #5 as the setpoint temperature monitor.
11. UV control panel reset.
12. Inject fluid to check:
    a. fluid lines full
    b. timing system correct
    c. UV system working properly (ignition occurs)

READY TO RUN FOR DATA!

## APPENDIX III

## DETAILED RUN PROCEDURES

A. Set target ventilation velocity

This run variable was set by a dial potentiometer on the facility control panel which positioned a butterfly valve to control flow. The velocity was calculated and available for monitoring on an on-line data display. The data sample rate for this display could be varied and was usually set for 100 data point reading average. The target values and the actual values (averaged) are presented on the Appendix E data sheets.

B. Set bleed duct target temperature

The duct surface temperature was a function of the heater sheath temperature which in turn was a function of the power input to the heaters. Power to the heater rods was varied by a set-point controller using the value of T/C #6, the thermocouple "buried" in the heater sheath, in a feed back loop. The duct surface temperature was cyclic for a given setting of the set-point controller.

Achieving the desired target temperature was a "trial and error" process and was a function of the value of the target temperature and the ventilating velocity. This relationship can be seen in the data shown in Appendix V.

The value of T/C #5 was used as the target temperature for all testing for two (2) reasons. First was an agreement among all participants to be consistent and second, the location was the coolest and thus was the most conservative in determining "minimum" ignition temperatures.

All temperature data were monitored on digital temperature indicatiors as well as on the facility data recording system..

C. Activate data recording system

The data recording system was manually activated at the direction of the facaility test engineer. His signal was based on:

1. The target temperature would be reached at or near the peak as the temperature was on the upswing of its cycle.
2. The averaged value of the velocity was within 0.10 fps of the target value.

Data was recorded in two (2) places. One on disk storage for later use and another on the on-line printer for current use. All recorded data was an average of 100 readings.

At the same time the facility test engineer signaled for data recording, he turned on the video tape recorder, announcing the run number and configuration.

D. Activate fluid injection

The fluid injection switch was activated by the facility test engineer when the on-line printer had completed the last line. Just prior to activating the switch, the facility test engineer announced the value of T/C #5 as indicated by the panel meter. This value was hand recorded and was also on the audio track of the video record. When the injection switch was positioned to the desired injection method, fluid was injected for a predetermined amount of time or until ignition occured. An elapsed time timer was also started. If the UV system detected an ignition, fuel injection was turned off and the timer stopped. If ignition did not occur, fluid was injected for the predetermined time and the timer continued to run until the injection switch was reset (normally 30 seconds after activation).

Observers called out if ignition occurred or not and, if so, what the elapsed time to ignition was. This information was hand recorded as well as being on the audio track of the video record. If ignition occurred, the target temperature was reduced.

E. Repeat B through D until three (3) sucessive NO IGNITION points were recorded for the same target temperature.

F. Change the ventilating velocity and repeat B through E.

G. Repeat F until the velocity range had been completed for the run configuration.

H. Repeat A through G for another run configuration.

APPENDIX IV

<u>IGNITIONS/ATTEMPTS PER SET-UP</u>

UNITS: FIGURES IV-1 THROUGH IV-17

Temperature---------- $^{\circ}$F
Nacelle Velocity----fps

# FIGURE IV-1

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
IGNITIONS/ATTEMPTS PER SET-UP

MIL-H-5606
BARE DUCT
SPRAY

| TEMP | NACELLE VELOCITY 0.0 | .5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 5.5 | 6.0 | 6.5 | 7.0 | 7.5 | 8.0 | 8.5 | 9.0 | 9.5 | 10.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1475 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1450 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1425 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1400 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1375 | . | . | . | . | . | . | . | . | . | . | . | . | 2/ 3 | . | . | . | 0/ 1 | . | . | . | . |
| 1350 | . | . | . | . | 2/ 2 | . | . | . | 1/ 2 | . | . | . | . | . | . | . | 2/ 2 | . | . | . | . |
| 1325 | . | . | . | . | . | . | . | . | 1/ 3 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1300 | . | . | . | . | 2/ 2 | . | . | . | 2/ 2 | . | . | . | 1/ 1 | . | . | . | 1/ 2 | . | . | . | . |
| 1275 | . | . | . | . | 1/ 1 | . | . | . | 1/ 2 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1250 | 1/ 1 | . | . | . | 2/ 3 | . | . | . | 1/ 4 | . | . | . | 0/ 2 | . | . | . | 0/ 3 | . | . | . | . |
| 1225 | . | . | 1/ 1 | . | 1/ 3 | . | . | . | 0/ 1 | . | . | . | 0/ 1 | . | . | . | . | . | . | . | . |
| 1200 | 1/ 2 | . | 2/ 2 | . | 2/ 2 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1175 | 1/ 2 | . | . | . | 1/ 5 | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1150 | 1/ 1 | . | 1/ 1 | . | 1/ 3 | . | . | . | 0/ 3 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1125 | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1100 | 1/ 1 | . | 1/ 1 | . | 1/ 2 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1075 | 0/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1050 | 1/ 1 | . | 1/ 1 | . | 0/ 3 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1025 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1000 | 0/ 3 | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 975 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 950 | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 925 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 900 | . | . | 0/ 3 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 875 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 850 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 825 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 800 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 775 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 750 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 725 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 700 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 675 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 650 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 625 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 600 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |

# FIGURE IV-2

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
IGNITIONS/ATTEMPTS PER SET-UP

MIL-H-5606
DUCT & CLAMP
SPRAY

| | NACELLE VELOCITY | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TEMP | 0.0 | .5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 5.5 | 6.0 | 6.5 | 7.0 | 7.5 | 8.0 | 8.5 | 9.0 | 9.5 | 10.0 |
| 1475 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1450 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1425 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1400 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1375 | . | . | . | . | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . |
| 1350 | . | . | . | . | . | . | . | . | . | . | . | . | 2/ 2 | . | . | . | . | . | . | . | . |
| 1325 | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | 0/ 3 | . | . | . | . | . | . | . | . |
| 1300 | . | . | . | . | 1/ 1 | . | . | . | 2/ 2 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1275 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1250 | . | . | . | . | . | . | . | . | 3/ 7 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1225 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1200 | 1/ 1 | . | 2/ 4 | . | . | . | 3/ 3 | . | 0/16 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1175 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1150 | 1/ 1 | . | 2/ 5 | . | 1/ 1 | . | 1/ 4 | . | | . | . | . | . | . | . | . | . | . | . | . | . |
| 1125 | . | . | . | . | . | . | 1/ 4 | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1100 | 1/ 3 | . | 1/ 4 | . | 1/ 1 | . | . | . | 0/ 1 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1075 | 0/ 3 | . | . | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1050 | . | . | 1/ 1 | . | 1/ 1 | . | . | . | 0/ 1 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1025 | . | . | . | . | . | . | 0/ 3 | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1000 | . | . | 1/ 4 | . | 1/ 1 | . | . | . | 0/ 2 | . | . | . | . | . | . | . | . | . | . | . | . |
| 975 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 950 | . | . | 0/ 3 | . | 1/ 3 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 925 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 900 | . | . | . | . | 0/ 3 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 875 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 850 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 825 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 800 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 775 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 750 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 725 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 700 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 675 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 650 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 625 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 600 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |

# FIGURE IV-3

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
IGNITIONS/ATTEMPTS PER SET-UP

MIL-H-5606
BARE DUCT
DRIP

| | NACELLE VELOCITY | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TEMP | 0.0 | .5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 5.5 | 6.0 | 6.5 | 7.0 | 7.5 | 8.0 | 8.5 | 9.0 | 9.5 | 10.0 |
| 1475 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1450 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1425 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1400 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | . |
| 1375 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1350 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 3/ 5 | . | . | . | . |
| 1325 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1300 | 1/ 1 | . | . | . | 1/ 1 | . | . | . | . | . | . | . | 1/ 1 | . | . | . | 0/ 1 | . | . | . | . |
| 1275 | . | . | . | . | . | . | . | . | . | . | . | . | 1/ 2 | . | . | . | 1/ 1 | . | . | . | . |
| 1250 | . | . | . | . | . | . | . | . | . | . | . | . | 1/ 2 | . | . | . | 0/ 3 | . | . | . | . |
| 1225 | 1/ 1 | . | . | . | . | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1200 | . | . | . | . | 3/ 4 | . | . | . | 2/ 3 | . | . | . | 0/ 3 | . | . | . | . | . | . | . | . |
| 1175 | 2/ 2 | . | . | . | . | . | . | . | 2/ 3 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1150 | 1/ 1 | . | . | . | 1/ 2 | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1125 | 2/ 2 | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1100 | 1/ 2 | . | 2/ 2 | . | . | . | . | . | 0/ 3 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1075 | . | . | . | . | 2/ 2 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1050 | 1/ 1 | . | . | . | 2/ 2 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1025 | . | . | 2/ 2 | . | 1/ 3 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1000 | 0/ 3 | 0/ 1 | 1/ 2 | . | 0/ 3 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 975 | . | . | . | . | 0/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 950 | . | . | 0/ 3 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 925 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 900 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 875 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 850 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 825 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 800 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 775 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 750 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 725 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 700 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 675 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 650 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 625 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 600 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |

# FIGURE IV-4

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
IGNITIONS/ATTEMPTS PER SET-UP

MIL-H-5606
DUCT & CLAMP
DRIP

| | NACELLE VELOCITY | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TEMP | 0.0 | .5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 5.5 | 6.0 | 6.5 | 7.0 | 7.5 | 8.0 | 8.5 | 9.0 | 9.5 | 10.0 |
| 1475 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1450 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1425 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1400 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1375 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1350 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | . |
| 1325 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1300 | . | . | 1/ 1 | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | . |
| 1275 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | . |
| 1250 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 2/ 2 | . | . | . | . |
| 1225 | . | . | . | . | . | . | . | . | 0/ 1 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1200 | 1/ 1 | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | . |
| 1175 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | . |
| 1150 | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | 4/ 4 | . | . | . | 0/ 3 | . | . | . | . |
| 1125 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1100 | 1/ 1 | . | 1/ 1 | . | 1/ 1 | . | . | . | . | . | . | 0/ 1 | 2/ 6 | . | . | . | . | . | . | . | . |
| 1075 | . | . | . | . | . | . | . | . | . | . | . | . | 1/ 4 | . | . | . | . | . | . | . | . |
| 1050 | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | 1/ 6 | . | . | . | . | . | . | . | . |
| 1025 | . | . | . | . | . | . | . | . | . | . | . | . | 0/ 3 | . | . | . | . | . | . | . | . |
| 1000 | 0/ 3 | . | . | . | 2/ 2 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 975 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 950 | . | . | . | . | 1/ 1 | . | . | . | 1/ 3 | . | . | . | . | . | . | . | . | . | . | . | . |
| 925 | . | . | . | . | . | . | . | . | 1/ 3 | . | . | . | . | . | . | . | . | . | . | . | . |
| 900 | . | . | 1/ 1 | . | 2/ 2 | . | . | . | 1/ 5 | . | . | . | . | . | . | . | . | . | . | . | . |
| 875 | . | . | . | . | . | . | . | . | 0/ 4 | . | . | . | . | . | . | . | . | . | . | . | . |
| 850 | . | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 825 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 800 | . | . | 0/ 3 | . | 2/ 2 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 775 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 750 | . | . | 1/ 3 | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 725 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 700 | . | . | 0/ 4 | . | 1/ 5 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 675 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 650 | . | . | . | . | 0/ 3 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 625 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 600 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |

## FIGURE IV-5



F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
IGNITIONS/ATTEMPTS PER SET-UP

MIL-H-5606
OBSTRUCTIONS
DRIP

| TEMP | NACELLE VELOCITY 0.0 | .5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 5.5 | 6.0 | 6.5 | 7.0 | 7.5 | 8.0 | 8.5 | 9.0 | 9.5 | 10.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1475 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1450 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1425 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1400 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1375 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1350 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1325 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1300 | . | . | . | . | 1/ 1 | . | . | . | 1/ 1 | . | . | . | . | . | . | . | 1/ 1 | . | . | . | 2/ 2 |
| 1275 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1250 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | 1/ 1 |
| 1225 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1200 | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | 1/ 1 | . | . | . | 1/ 1 | . | . | . | 0/ 4 |
| 1175 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1150 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1/ 2 | . | . | . | . |
| 1125 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1100 | 1/ 1 | . | 2/ 2 | . | . | . | . | . | 1/ 1 | . | . | . | 1/ 1 | . | . | . | 0/ 3 | . | . | . | . |
| 1075 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1050 | 1/ 1 | . | 1/ 1 | . | . | . | . | . | . | . | . | . | 0/ 3 | . | . | . | . | . | . | . | . |
| 1025 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1000 | 1/ 2 | . | 1/ 2 | . | 2/ 2 | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . |
| 975 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 950 | 0/ 3 | . | 1/ 2 | . | . | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . |
| 925 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 900 | . | . | 1/ 1 | . | 1/ 1 | . | . | . | 0/ 3 | . | . | . | . | . | . | . | . | . | . | . | . |
| 875 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 850 | . | . | 1/ 2 | . | 0/ 3 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 825 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 800 | . | . | 0/ 3 | . | 0/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 775 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 750 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 725 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 700 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 675 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 650 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 625 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 600 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |

# FIGURE IV-6

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
IGNITIONS/ATTEMPTS PER SET-UP

JP-4
BARE DUCT
SPRAY

| TEMP | NACELLE VELOCITY 0.0 | .5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 5.5 | 6.0 | 6.5 | 7.0 | 7.5 | 8.0 | 8.5 | 9.0 | 9.5 | 10.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1475 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1450 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1425 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1400 | . | . | . | . | 2/ 6 | . | . | . | 1/ 1 | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . |
| 1375 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | . |
| 1350 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | . |
| 1325 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | . |
| 1300 | 2/ 4 | . | 0/ 2 | . | 1/15 | . | . | . | 1/ 1 | . | . | . | 2/ 3 | . | . | . | 1/ 3 | . | . | . | . |
| 1275 | 0/ 2 | . | . | . | 1/ 1 | . | . | . | 3/ 4 | . | . | . | 1/ 1 | . | . | . | 1/ 2 | . | . | . | . |
| 1250 | . | . | . | . | 0/ 4 | . | . | . | 0/ 3 | . | . | . | 0/ 3 | . | . | . | 0/ 3 | . | . | . | . |
| 1225 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1200 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1175 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1150 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1125 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1100 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1075 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1050 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1025 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1000 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 975 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 950 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 925 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 900 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 875 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 850 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 825 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 800 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 775 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 750 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 725 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 700 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 675 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 650 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 625 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 600 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |

# FIGURE IV-7

PAGE : 1

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
IGNITIONS/ATTEMPTS PER SET-UP

JP-4
DUCT & CLAMP
SPRAY

NACELLE VELOCITY

| TEMP | 0.0 | .5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 5.5 | 6.0 | 6.5 | 7.0 | 7.5 | 8.0 | 8.5 | 9.0 | 9.5 | 10.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1475 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1450 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1425 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1400 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1375 | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | 0/ 2 | . | . | . | . | . | . | . | . |
| 1350 | . | . | . | . | 2/ 2 | . | . | . | 2/ 3 | . | . | . | 0/ 3 | . | . | . | . | . | . | . | . |
| 1325 | 1/ 1 | . | . | . | . | . | . | . | 0/ 7 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1300 | 1/ 1 | . | . | . | 4/ 4 | . | . | . | 0/ 5 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1275 | 2/ 3 | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1250 | 0/ 3 | . | . | . | 1/ 9 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1225 | . | . | . | . | 0/ 3 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1200 | . | . | . | . | 0/ 3 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1175 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1150 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1125 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1100 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1075 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1050 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1025 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1000 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 975 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 950 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 925 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 900 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 875 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 850 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 825 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 800 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 775 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 750 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 725 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 700 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 675 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 650 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 625 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 600 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |

# FIGURE IV-8



F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
IGNITIONS/ATTEMPTS PER SET-UP

JP-4
BARE DUCT
DRIP

| | NACELLE VELOCITY | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TEMP | 0.0 | .5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 5.5 | 6.0 | 6.5 | 7.0 | 7.5 | 8.0 | 8.5 | 9.0 | 9.5 | 10.0 |
| 1475 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1450 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1425 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1400 | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | 1/ 3 | . | . | . | . | . | . | . | . |
| 1375 | . | . | . | . | . | . | . | . | . | . | . | . | 1/ 5 | . | . | . | . | . | . | . | . |
| 1350 | 1/ 1 | . | . | . | . | . | . | . | 3/ 3 | . | . | . | 1/ 2 | . | . | . | 1/ 1 | . | . | . | . |
| 1325 | 1/ 1 | . | . | . | . | . | . | . | 2/ 7 | . | . | . | 1/ 1 | . | . | . | 0/ 3 | . | . | . | . |
| 1300 | 1/ 2 | . | . | . | 3/ 3 | . | . | . | 1/ 5 | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . |
| 1275 | 1/ 3 | . | 2/ 2 | 1/ 1 | . | . | . | . | 1/ 2 | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . |
| 1250 | 0/ 5 | . | 1/ 3 | . | 1/ 3 | . | . | . | 0/ 5 | . | . | . | 0/ 3 | . | . | . | . | . | . | . | . |
| 1225 | . | . | 2/ 5 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1200 | . | . | 0/ 6 | 0/ 3 | 1/ 4 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1175 | . | . | . | . | 0/ 3 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1150 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1125 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1100 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1075 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1050 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1025 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1000 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 975 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 950 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 925 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 900 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 875 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 850 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 825 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 800 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 775 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 750 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 725 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 700 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 675 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 650 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 625 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 600 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |

# FIGURE IV-9



F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
IGNITIONS/ATTEMPTS PER SET-UP

JP-4
DUCT & CLAMP
DRIP

| | NACELLE VELOCITY | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TEMP | 0.0 | .5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 5.5 | 6.0 | 6.5 | 7.0 | 7.5 | 8.0 | 8.5 | 9.0 | 9.5 | 10.0 |
| 1475 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1450 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1425 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1400 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1375 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1350 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1325 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1300 | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | 1/ 1 | . | . | . | . |
| 1275 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1250 | . | . | . | . | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . |
| 1225 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1200 | 1/ 1 | . | 1/ 1 | . | 2/ 2 | . | . | . | 1/ 1 | . | . | . | 1/ 1 | . | . | . | 1/ 1 | . | . | . | . |
| 1175 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1150 | . | . | . | . | 1/ 1 | . | . | . | 2/ 2 | . | . | . | 1/ 2 | . | . | . | 0/ 3 | . | . | . | . |
| 1125 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1100 | 1/ 2 | . | 1/ 1 | . | 3/ 3 | . | . | . | 1/ 1 | . | . | . | 0/ 3 | . | . | . | . | . | . | . | . |
| 1075 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1050 | 1/ 3 | . | 1/ 1 | . | 2/ 2 | . | . | . | 0/ 3 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1025 | . | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1000 | 0/ 3 | . | 1/ 2 | . | 1/ 4 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 975 | . | . | . | . | 1/ 2 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 950 | . | . | 1/ 3 | . | 0/ 3 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 925 | . | . | . | . | 0/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 900 | . | . | 0/ 3 | . | 0/ 2 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 875 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 850 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 825 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 800 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 775 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 750 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 725 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 700 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 675 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 650 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 625 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 600 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |

# FIGURE IV-10

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
IGNITIONS/ATTEMPTS PER SET-UP

JP-4
OBSTRUCTIONS
DRIP

| | NACELLE VELOCITY | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TEMP | 0.0 | .5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 5.5 | 6.0 | 6.5 | 7.0 | 7.5 | 8.0 | 8.5 | 9.0 | 9.5 | 10.0 |
| 1475 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1450 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1425 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1400 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1375 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1350 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1325 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1300 | . | . | . | . | 1/ 1 | . | . | . | 1/ 1 | . | . | . | 1/ 1 | . | . | . | 1/ 1 | . | . | . | . |
| 1275 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1250 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1225 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1200 | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | 1/ 1 | . | . | . | . |
| 1175 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1150 | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | 0/ 3 | . | . | . | . |
| 1125 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1100 | 1/ 1 | . | 1/ 1 | . | 1/ 1 | . | . | . | 1/ 1 | . | . | . | 0/ 3 | . | . | . | . | . | . | . | . |
| 1075 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1050 | 0/ 3 | . | 1/ 4 | . | 1/ 1 | . | . | . | 0/ 3 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1025 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1000 | . | . | 0/ 3 | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 975 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 950 | . | . | . | . | 1/ 3 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 925 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 900 | . | . | . | . | 0/ 3 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 875 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 850 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 825 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 800 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 775 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 750 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 725 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 700 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 675 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 650 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 625 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 600 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |

# FIGURE IV-11

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
IGNITIONS/ATTEMPTS PER SET-UP

MIL-H-83282
BARE DUCT
SPRAY

| | NACELLE VELOCITY | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TEMP | 0.0 | .5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 5.5 | 6.0 | 6.5 | 7.0 | 7.5 | 8.0 | 8.5 | 9.0 | 9.5 | 10.0 |
| 1475 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1450 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1425 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1400 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | . |
| 1375 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | . |
| 1350 | . | . | . | . | 1/ 1 | . | . | . | . | . | . | . | 1/ 1 | . | . | . | 2/ 3 | . | . | . | . |
| 1325 | . | . | . | . | 2/ 2 | . | . | . | . | . | . | . | 1/ 1 | . | . | . | 1/ 1 | . | . | . | . |
| 1300 | . | . | . | . | 1/ 1 | . | . | . | . | . | . | . | 1/ 1 | . | . | . | 0/ 2 | . | . | . | . |
| 1275 | . | . | . | . | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . |
| 1250 | . | . | . | . | 1/ 1 | . | . | . | . | . | . | . | 0/ 2 | . | . | . | . | . | . | . | . |
| 1225 | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1200 | . | . | . | . | . | . | . | . | 2/ 2 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1175 | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1150 | . | . | . | . | 1/ 1 | . | 1/ 1 | . | 1/ 3 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1125 | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1100 | . | . | . | . | 1/ 1 | . | 1/ 1 | . | 3/ 5 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1075 | 1/ 1 | . | . | . | . | . | 2/ 2 | . | 0/ 6 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1050 | 1/ 1 | . | . | . | . | . | 1/ 2 | . | 0/ 1 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1025 | . | . | . | . | 1/ 1 | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1000 | 1/ 1 | . | . | . | 1/ 1 | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 975 | . | . | . | . | . | . | 1/ 3 | . | 0/ 1 | . | . | . | . | . | . | . | . | . | . | . | . |
| 950 | 0/ 2 | . | . | . | 1/ 1 | . | 0/ 2 | . | 0/ 1 | . | . | . | . | . | . | . | . | . | . | . | . |
| 925 | . | . | . | . | 1/ 2 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 900 | . | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 875 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 850 | . | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 825 | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 800 | . | . | 1/ 1 | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 775 | . | . | 1/ 1 | . | 1/ 2 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 750 | . | . | 1/ 2 | . | 0/ 2 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 725 | . | . | 1/ 2 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 700 | . | . | 0/ 2 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 675 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 650 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 625 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 600 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |

# FIGURE IV-12

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
IGNITIONS/ATTEMPTS PER SET-UP

MIL-H-83282
DUCT & CLAMP
SPRAY

NACELLE VELOCITY

| TEMP | 0.0 | .5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 5.5 | 6.0 | 6.5 | 7.0 | 7.5 | 8.0 | 8.5 | 9.0 | 9.5 | 10.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1475 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1450 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1425 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1400 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1375 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1350 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1325 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1300 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | . |
| 1275 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1250 | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | 2/ 2 | . | . | . | 3/ 3 | . | . | . | . |
| 1225 | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 0/ 1 | . | . | . | . |
| 1200 | . | . | . | . | . | . | . | . | . | . | . | . | 2/ 2 | . | . | . | 1/ 1 | . | . | . | . |
| 1175 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1150 | 0/ 1 | . | . | . | . | . | . | . | 1/ 1 | . | 1/ 1 | . | 2/ 2 | . | 2/ 3 | . | 1/ 3 | . | . | . | . |
| 1125 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1100 | . | . | . | . | . | . | . | . | . | . | . | . | 1/ 2 | . | 1/ 1 | . | 1/ 2 | . | . | . | . |
| 1075 | . | . | . | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1050 | . | . | . | . | . | . | 1/ 1 | . | 3/ 3 | . | 1/ 1 | . | 0/ 5 | . | 0/ 3 | . | 0/ 5 | . | . | . | . |
| 1025 | 1/ 1 | . | . | . | . | . | 1/ 1 | . | 0/ 1 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1000 | 1/ 1 | . | . | . | 1/ 2 | . | . | . | 1/ 3 | . | 1/ 4 | . | . | . | . | . | . | . | . | . | . |
| 975 | 0/ 1 | . | . | . | . | . | 1/ 1 | . | 1/ 7 | . | 0/ 3 | . | . | . | . | . | . | . | . | . | . |
| 950 | 1/ 1 | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 925 | . | . | . | 4/ 4 | 1/ 1 | . | 1/ 1 | . | 0/ 3 | . | . | . | . | . | . | . | . | . | . | . | . |
| 900 | 1/ 2 | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 875 | . | . | . | 1/ 1 | . | . | 1/ 6 | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 850 | 0/ 3 | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 825 | 0/ 1 | . | . | 0/ 2 | 1/ 9 | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 800 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 775 | . | . | . | 1/13 | 1/ 2 | . | 0/ 3 | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 750 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 725 | . | . | . | 0/ 3 | 0/ 4 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 700 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 675 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 650 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 625 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 600 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |

# FIGURE IV-13

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
IGNITIONS/ATTEMPTS PER SET-UP

MIL-H-83282
BARE DUCT
DRIP

| TEMP | 0.0 | .5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 5.5 | 6.0 | 6.5 | 7.0 | 7.5 | 8.0 | 8.5 | 9.0 | 9.5 | 10.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1475 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1450 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1425 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1400 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1375 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1350 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 3/ 4 | . | . | . | . |
| 1325 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 0/ 3 | . | . | . | . |
| 1300 | 2/ 2 | . | . | . | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . |
| 1275 | . | . | . | . | 1/ 2 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1250 | 2/ 2 | . | . | . | 4/ 4 | . | . | . | 1/ 2 | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . |
| 1225 | . | . | . | . | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . |
| 1200 | 1/ 2 | . | . | . | 4/ 4 | . | . | . | 1/ 2 | . | . | . | 0/ 3 | . | . | . | . | . | . | . | . |
| 1175 | 0/ 1 | . | . | . | 3/ 5 | . | . | . | 2/ 5 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1150 | 1/ 2 | . | . | . | 1/ 1 | . | . | . | 0/ 4 | . | . | . | 0/ 2 | . | . | . | 0/ 1 | . | . | . | . |
| 1125 | . | . | 1/ 1 | . | 3/ 5 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1100 | 0/ 3 | . | 2/ 2 | . | 0/ 5 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1075 | . | . | 2/ 3 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1050 | . | . | 1/ 2 | . | 0/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1025 | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1000 | . | . | 2/ 6 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 975 | . | . | 0/ 4 | . | 0/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 950 | . | . | 0/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 925 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 900 | . | . | . | . | 0/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 875 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 850 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 825 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 800 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 775 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 750 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 725 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 700 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 675 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 650 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 625 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 600 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |

# FIGURE IV-14

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
IGNITIONS/ATTEMPTS PER SET-UP

MIL-H-83282
DUCT & CLAMP
DRIP

| TEMP | NACELLE VELOCITY 0.0 | .5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 5.5 | 6.0 | 6.5 | 7.0 | 7.5 | 8.0 | 8.5 | 9.0 | 9.5 | 10.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1475 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1450 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1425 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1400 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1375 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1350 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1325 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1300 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1275 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1250 | . | . | . | . | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . |
| 1225 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1200 | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1175 | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1150 | . | . | 2/ 2 | . | 1/ 1 | . | . | . | 1/ 1 | . | . | . | 2/ 2 | . | . | . | 1/ 1 | . | . | . | . |
| 1125 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1100 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1075 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1050 | . | . | 1/ 1 | . | 1/ 1 | . | . | . | . | . | . | . | 1/ 1 | . | . | . | 1/ 1 | . | . | . | . |
| 1025 | . | . | . | . | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . |
| 1000 | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 0/ 5 | . | . | . | . |
| 975 | . | . | . | . | 1/ 1 | . | . | . | 2/ 3 | . | . | . | 0/ 2 | . | . | . | . | . | . | . | . |
| 950 | 1/ 1 | . | . | . | 2/ 2 | . | . | . | . | . | . | . | 0/ 1 | . | . | . | . | . | . | . | . |
| 925 | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . |
| 900 | 1/ 3 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 875 | . | . | 1/ 1 | . | 1/ 1 | . | . | . | 1/ 2 | . | . | . | . | . | . | . | . | . | . | . | . |
| 850 | 0/ 3 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 825 | . | . | 1/ 1 | . | . | . | . | . | 0/ 6 | . | . | . | . | . | . | . | . | . | . | . | . |
| 800 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 775 | . | . | 1/ 1 | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 750 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 725 | . | . | 0/ 8 | . | 0/ 6 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 700 | . | . | 0/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 675 | . | . | . | . | 0/ 3 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 650 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 625 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 600 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |

# FIGURE IV-15



F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
IGNITIONS/ATTEMPTS PER SET-UP

MIL-H-83282
OBSTRUCTIONS
DRIP

| | NACELLE VELOCITY | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TEMP | 0.0 | .5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 5.5 | 6.0 | 6.5 | 7.0 | 7.5 | 8.0 | 8.5 | 9.0 | 9.5 | 10.0 |
| 1475 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1450 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1425 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1400 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1375 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1350 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1325 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1300 | . | . | . | . | 1/ 1 | . | . | . | 1/ 1 | . | . | . | 1/ 1 | . | . | . | 1/ 1 | . | . | . | . |
| 1275 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1250 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1225 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1200 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1175 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1150 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1125 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1100 | . | . | . | . | 1/ 1 | . | . | . | 1/ 1 | . | . | . | 1/ 1 | . | . | . | 1/ 1 | . | . | . | . |
| 1075 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1050 | . | . | . | . | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | 1/ 2 | . | . | . | . |
| 1025 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1000 | 1/ 1 | . | 2/ 2 | . | 2/ 2 | . | . | . | 1/ 1 | . | . | . | 1/ 1 | . | . | . | 0/ 3 | . | . | . | . |
| 975 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 950 | 1/ 1 | . | 1/ 1 | . | . | . | . | . | 1/ 1 | . | . | . | 0/ 3 | . | . | . | . | . | . | . | . |
| 925 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 900 | 0/ 3 | . | 1/ 3 | . | 2/ 3 | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . |
| 875 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 850 | . | . | 1/ 1 | . | 2/ 2 | . | . | . | 1/ 2 | . | . | . | . | . | . | . | . | . | . | . | . |
| 825 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 800 | . | . | 0/ 3 | . | 0/ 5 | . | . | . | 0/ 3 | . | . | . | . | . | . | . | . | . | . | . | . |
| 775 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 750 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 725 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 700 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 675 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 650 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 625 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 600 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |

# FIGURE IV-16



F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
IGNITIONS/ATTEMPTS PER SET-UP

MIL-L-7808
BARE DUCT
SPRAY

| | NACELLE VELOCITY | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TEMP | 0.0 | .5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 5.5 | 6.0 | 6.5 | 7.0 | 7.5 | 8.0 | 8.5 | 9.0 | 9.5 | 10.0 |
| 1475 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1450 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1425 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1400 | . | . | 1/ 1 | . | 3/ 3 | . | . | . | 1/ 1 | . | . | . | 2/ 5 | . | . | . | 0/ 4 | . | . | . | . |
| 1375 | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | 2/ 2 | . | . | . | . | . | . | . | . |
| 1350 | . | . | 1/ 1 | . | . | . | . | . | 1/ 2 | . | . | . | 1/ 1 | . | 1/ 1 | . | . | . | . | . | . |
| 1325 | . | . | . | . | . | . | . | . | 2/ 2 | . | . | . | 0/ 3 | . | 0/ 3 | . | . | . | . | . | . |
| 1300 | 1/ 1 | . | 1/ 1 | . | 3/ 4 | . | . | . | 2/ 3 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1275 | . | . | . | . | . | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1250 | . | . | 1/ 1 | . | 4/ 6 | . | . | . | 1/ 5 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1225 | 1/ 1 | . | 1/ 1 | . | 2/ 4 | . | . | . | 0/ 4 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1200 | 0/ 5 | . | 2/ 2 | . | 1/ 5 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1175 | . | . | 1/ 3 | . | 0/ 3 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1150 | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1125 | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1100 | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1075 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1050 | . | . | 1/ 2 | . | 0/ 1 | . | . | . | 0/ 1 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1025 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1000 | . | . | 0/ 3 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 975 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 950 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 925 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 900 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 875 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 850 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 825 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 800 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 775 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 750 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 725 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 700 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 675 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 650 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 625 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 600 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |

## FIGURE IV-17



F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
IGNITIONS/ATTEMPTS PER SET-UP

MIL-L-7808
BARE DUCT
DRIP

| | NACELLE VELOCITY | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TEMP | 0.0 | .5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 5.5 | 6.0 | 6.5 | 7.0 | 7.5 | 8.0 | 8.5 | 9.0 | 9.5 | 10.0 |
| 1475 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1450 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1425 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1400 | . | . | . | . | 1/ 1 | . | . | . | . | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . |
| 1375 | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | 0/ 3 | . | . | . | . | . | . | . | . |
| 1350 | 1/ 1 | . | . | . | 1/ 1 | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1325 | 1/ 1 | . | . | . | . | . | . | . | 1/ 1 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1300 | 1/ 1 | . | . | . | 1/ 1 | . | . | . | 0/ 3 | . | . | . | . | . | . | . | . | . | . | . | . |
| 1275 | 0/ 4 | . | 2/ 3 | . | 1/ 2 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1250 | . | . | 0/ 3 | . | 1/ 2 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1225 | . | . | . | . | 0/ 3 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1200 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1175 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1150 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1125 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1100 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1075 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1050 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1025 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 1000 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 975 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 950 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 925 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 900 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 875 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 850 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 825 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 800 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 775 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 750 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 725 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 700 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 675 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 650 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 625 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 600 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |

## APPENDIX V

## COMPLETE RUN SUMMARY

UNITS FOR VARIABLES IN TABLES V-1 THROUGH V-17

Velocity------------------fps
Temperature---------------°F
Injection Time------------seconds
Combustion Time-----------seconds
Fuel Flow-----------------cc per second
Fuel Reg.
  Spray injection--------psig
  Drip injection---------micro valve setting
MIT delta-----------------°F

The two right hand columns labeled "OVERALL" coordinate these data with the Appendix IV data presentation. The "LITES/ATTEMPT" column tabulates the total ignitions and number of times fluid was injected. If more than one attempt is shown for a data point then additional points for the test condition will be contained in the table. The test condition temperature is above the MIT value for that velocity by the amount shown in the "MIT DELTA" column. For example, the underlined data points in Table V-1 are the individual points for the summary point shown by Figure IV-1 at a velocity of 2.0 fps and a temperature of 1225 °F. This temperature is 175 degrees above the minimum of 1050 °F.

# TABLE V-1



F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

MIL-H-5606
BARE DUCT
SPRAY

| RUN/PT. | --- TEST -- CONDITIONS VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | ------------- THERMOCOUPLES ------------- T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | --- OVERALL --- LITES / ATTEMPT | M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5/ 1 | 2.0 | 1225 | 5 | NO | - | 1253.9 | 1283.6 | 1306.3 | 1259.0 | 1232.6 | 1467.5 | 1.98 | 8.23 | 102.8 | 1/ 3 | 175.0 |
| 5/ 2 | 4.0 | 1225 | 5 | NO | - | 1250.9 | 1286.7 | 1320.7 | 1254.3 | 1230.6 | 1489.0 | 3.95 | 8.20 | 102.2 | 0/ 1 | 75.0 |
| 5/ 3 | 4.0 | 1275 | 5 | NO | - | 1295.2 | 1335.6 | 1361.1 | 1321.7 | 1272.4 | 1532.6 | 4.01 | 8.18 | 101.6 | 1/ 2 | 125.0 |
| 5/ 4 | 4.0 | 1300 | 5 | YES | 6.7 | 1315.0 | 1366.5 | 1388.0 | 1346.7 | 1298.5 | 1567.2 | 4.02 | 13.09 | 274.2 | 2/ 2 | 150.0 |
| 5/ 5 | 4.0 | 1250 | 5 | NO | - | 1264.5 | 1278.4 | 1337.7 | 1266.3 | 1243.0 | 1482.3 | 4.02 | 13.00 | 270.3 | 1/ 4 | 100.0 |
| 5/ 6 | 4.0 | 1250 | 5 | NO | - | 1264.5 | 1278.4 | 1337.7 | 1266.3 | 1243.0 | 1492.3 | 4.02 | 13.00 | 270.3 | 1/ 4 | 100.0 |
| 5/ 7 | 4.0 | 1325 | 5 | NO | - | 1355.4 | 1359.8 | 1424.3 | 1346.7 | 1327.4 | 1584.1 | 4.01 | 12.94 | 267.4 | 1/ 3 | 175.0 |
| 5/ 8 | 4.0 | 1325 | 5 | NO | - | 1352.3 | 1362.1 | 1422.5 | 1345.1 | 1326.0 | 1586.0 | 4.02 | 12.90 | 265.8 | 1/ 3 | 175.0 |
| 5/ 9 | 2.0 | 1350 | 5 | YES | 5.7 | 1382.6 | 1384.8 | 1432.6 | 1372.8 | 1358.6 | 1606.6 | 2.04 | 12.85 | 263.6 | 2/ 2 | 300.0 |
| 5/ 10 | 2.0 | 1300 | 5 | YES | 5.9 | 1326.7 | 1333.3 | 1375.5 | 1316.7 | 1297.6 | 1541.1 | 2.01 | 12.78 | 260.6 | 2/ 2 | 250.0 |
| 5/ 11 | 2.0 | 1275 | 5 | YES | 6.3 | 1307.7 | 1324.6 | 1355.5 | 1313.1 | 1278.4 | 1510.4 | 2.01 | 12.77 | 259.9 | 1/ 1 | 225.0 |
| 5/ 12 | 2.0 | 1250 | 5 | YES | 6.1 | 1265.9 | 1281.7 | 1317.5 | 1269.1 | 1244.6 | 1479.5 | 2.02 | 12.77 | 259.9 | 2/ 3 | 200.0 |
| 5/ 13 | 2.0 | 1225 | 5 | YES | 7.0 | 1256.8 | 1272.8 | 1301.4 | 1260.7 | 1229.3 | 1450.7 | 2.01 | 12.76 | 259.3 | 1/ 3 | 175.0 |
| 5/ 14 | 2.0 | 1200 | 5 | YES | 6.8 | 1220.3 | 1239.7 | 1272.5 | 1223.0 | 1199.8 | 1421.6 | 1.98 | 12.76 | 259.5 | 2/ 2 | 150.0 |
| 5/ 15 | 2.0 | 1175 | 5 | NO | - | 1198.0 | 1205.8 | 1247.5 | 1198.2 | 1174.2 | 1398.1 | 2.05 | 12.76 | 259.4 | 1/ 5 | 125.0 |
| 5/ 16 | 2.0 | 1175 | 5 | NO | - | 1208.8 | 1220.2 | 1256.6 | 1212.6 | 1179.2 | 1409.6 | 1.98 | 8.18 | 101.7 | 1/ 5 | 125.0 |
| 5/ 17 | 0.0 | 1175 | 5 | NO | - | 1186.7 | 1146.3 | 1219.0 | 1137.5 | 1165.1 | 1328.4 | 0.00 | 8.19 | 101.8 | 1/ 2 | 175.0 |
| 5/ 18 | 0.0 | 1200 | 5 | NO | - | 1209.3 | 1164.5 | 1245.6 | 1164.8 | 1190.2 | 1352.5 | 0.00 | 8.17 | 101.5 | 1/ 2 | 200.0 |
| 5/ 19 | 0.0 | 1250 | 5 | YES | 11.4 | 1256.2 | 1209.8 | 1294.2 | 1209.9 | 1239.8 | 1412.6 | 0.00 | 8.16 | 101.2 | 1/ 1 | 250.0 |
| 5/ 20 | 6.0 | 1375 | 5 | YES | 5.8 | 1417.7 | 1440.2 | 1484.3 | 1431.4 | 1384.6 | 1704.3 | 6.04 | 13.00 | 270.3 | 2/ 3 | 125.0 |
| 5/ 21 | 6.0 | 1375 | 5 | NO | - | 1385.7 | 1428.3 | 1460.1 | 1408.3 | 1365.8 | 1664.0 | 5.94 | 12.97 | 268.0 | 2/ 3 | 125.0 |
| 5/ 22 | 4.0 | 1325 | 5 | YES | 5.6 | 1335.8 | 1354.6 | 1396.2 | 1349.2 | 1312.8 | 1585.5 | 3.94 | 12.94 | 267.6 | 1/ 3 | 175.0 |
| 5/ 23 | 4.0 | 1275 | 5 | YES | 6.4 | 1296.3 | 1334.6 | 1366.4 | 1320.9 | 1282.5 | 1546.4 | 3.99 | 12.91 | 266.3 | 1/ 2 | 125.0 |
| 5/ 24 | 1.0 | 1225 | 5 | YES | 6.2 | 1242.3 | 1237.5 | 1273.8 | 1231.4 | 1220.0 | 1417.3 | 1.20 | 12.89 | 265.3 | 1/ 1 | 325.0 |
| 5/ 25 | 1.0 | 1200 | 5 | YES | 7.3 | 1197.4 | 1208.7 | 1228.3 | 1190.4 | 1190.0 | 1389.9 | 1.00 | 12.87 | 264.5 | 2/ 2 | 300.0 |
| 5/ 26 | 1.0 | 1125 | 5 | YES | 7.0 | 1155.3 | 1152.7 | 1179.7 | 1139.4 | 1133.4 | 1332.2 | 1.07 | 12.84 | 263.0 | 1/ 1 | 225.0 |
| 26/ 1 | 2.0 | 1350 | 5 | YES | 2.3 | 1377.4 | 1414.2 | 1441.4 | 75.7 | 1350.3 | 1642.8 | 2.04 | 8.11 | 99.9 | 2/ 2 | 300.0 |
| 26/ 2 | 2.0 | 1250 | 5 | NO | - | 1270.4 | 1314.9 | 1335.3 | 77.2 | 1245.5 | 1515.8 | 2.06 | 8.07 | 99.1 | 2/ 3 | 200.0 |
| 26/ 3 | 2.0 | 1300 | 5 | YES | 5.9 | 1301.5 | 1360.9 | 1389.4 | 76.0 | 1295.4 | 1590.5 | 2.04 | 8.06 | 98.8 | 2/ 2 | 250.0 |
| 26/ 4 | 2.0 | 1225 | 5 | NO | - | 1259.1 | 1301.9 | 1329.8 | 73.6 | 1235.6 | 1508.2 | 2.04 | 8.03 | 98.1 | 1/ 3 | 175.0 |
| 26/ 5 | 2.0 | 1250 | 10 | YES | 10.9 | 1225.4 | 1311.7 | 1342.9 | 75.4 | 1244.1 | 1522.6 | 2.02 | 8.02 | 97.9 | 2/ 3 | 200.0 |
| 26/ 6 | 2.0 | 1200 | 10 | YES | 11.3 | 1216.7 | 1263.5 | 1289.9 | 76.9 | 1193.2 | 1459.2 | 1.94 | 8.00 | 97.3 | 2/ 2 | 150.0 |
| 26/ 7 | 2.0 | 1175 | 10 | NO | - | 1186.1 | 1244.8 | 1264.9 | 76.5 | 1168.0 | 1438.5 | 2.00 | 7.98 | 96.8 | 1/ 5 | 125.0 |
| 26/ 9 | 2.0 | 1175 | 10 | NO | - | 1164.3 | 1247.0 | 1277.7 | 75.7 | 1174.1 | 1450.0 | 2.03 | 7.95 | 96.3 | 1/ 5 | 125.0 |
| 26/ 10 | 2.0 | 1175 | 10 | YES | 11.1 | 1146.3 | 1248.2 | 1277.3 | 78.3 | 1170.0 | 1447.1 | 2.05 | 7.93 | 95.7 | 1/ 5 | 125.0 |
| 26/ 11 | 2.0 | 1150 | 10 | NO | - | 1141.4 | 1222.2 | 1251.0 | 73.3 | 1148.9 | 1421.3 | 2.02 | 8.07 | 99.0 | 1/ 3 | 100.0 |
| 26/ 12 | 2.0 | 1150 | 10 | NO | - | 1116.3 | 1222.2 | 1257.5 | 76.4 | 1146.2 | 1419.8 | 2.03 | 8.05 | 98.5 | 1/ 3 | 100.0 |
| 26/ 13 | 2.0 | 1150 | 10 | YES | 10.8 | 1099.7 | 1222.5 | 1261.2 | 75.8 | 1145.8 | 1427.0 | 2.00 | 8.02 | 97.9 | 1/ 3 | 100.0 |
| 26/ 14 | 2.0 | 1100 | 10 | NO | - | 1079.7 | 1172.5 | 1205.7 | 77.7 | 1096.3 | 1359.8 | 2.01 | 8.00 | 97.4 | 1/ 2 | 50.0 |
| 26/ 15 | 2.0 | 1100 | 10 | YES | 10.9 | 1054.3 | 1177.6 | 1208.6 | 77.2 | 1097.4 | 1358.5 | 2.03 | 7.98 | 97.0 | 1/ 2 | 50.0 |

# TABLE V-1

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

MIL-H-5606
BARE DUCT
SPRAY

| RUN/PT. | --- TEST -- CONDITIONS VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | THERMOCOUPLES T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | --- OVERALL --- LITES / ATTEMPT | M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26/ 16 | 2.0 | 1050 | 10 | NO | - | 1040.9 | 1122.2 | 1155.4 | 77.6 | 1043.2 | 1304.3 | 2.05 | 7.96 | 96.5 | 0/ 3 | 0.0 |
| 26/ 17 | 2.0 | 1050 | 10 | NO | - | 1007.9 | 1130.2 | 1159.7 | 71.2 | 1049.3 | 1310.3 | 2.08 | 7.92 | 95.5 | 0/ 3 | 0.0 |
| 26/ 18 | 2.0 | 1050 | 0 | NO | - | 1018.7 | 1128.2 | 1161.7 | 76.6 | 1046.9 | 1309.2 | 2.04 | 7.88 | 94.6 | 0/ 3 | 0.0 |
| 26/ 19 | 2.0 | 1050 | 10 | NO | - | 1057.7 | 1118.7 | 1124.6 | 78.4 | 1050.2 | 1272.3 | 2.06 | 7.96 | 96.4 | 0/ 3 | 0.0 |
| 26/ 20 | 4.0 | 1350 | 10 | NO | - | 1334.7 | 1413.3 | 1457.9 | 76.2 | 1338.1 | 1675.1 | 3.97 | 7.92 | 95.4 | 1/ 2 | 200.0 |
| 26/ 21 | 4.0 | 1350 | 5 | YES | .5 | 1216.4 | 1421.9 | 1459.8 | 78.6 | 1346.8 | 1683.5 | 4.01 | 13.14 | 276.5 | 1/ 2 | 200.0 |
| 26/ 22 | 4.0 | 1300 | 5 | YES | 5.5 | 1318.7 | 1372.1 | 1409.0 | 78.6 | 1295.5 | 1619.2 | 4.01 | 13.07 | 273.4 | 2/ 2 | 150.0 |
| 26/ 23 | 4.0 | 1250 | 5 | NO | - | 1277.2 | 1334.8 | 1372.4 | 78.2 | 1254.0 | 1576.8 | 4.01 | 12.95 | 268.0 | 1/ 4 | 100.0 |
| 26/ 24 | 4.0 | 1250 | 5 | YES | 5.6 | 1251.7 | 1322.7 | 1366.3 | 73.7 | 1241.8 | 1567.5 | 3.97 | 12.91 | 266.0 | 1/ 4 | 100.0 |
| 26/ 25 | 4.0 | 1175 | 5 | YES | 5.9 | 1206.2 | 1271.5 | 1309.9 | 74.6 | 1187.2 | 1499.7 | 4.02 | 12.86 | 263.8 | 1/ 1 | 25.0 |
| 26/ 26 | 4.0 | 1150 | 5 | NO | - | 1158.3 | 1237.0 | 1274.1 | 75.5 | 1148.8 | 1458.0 | 3.99 | 12.81 | 261.6 | 0/ 3 | 0.0 |
| 26/ 27 | 4.0 | 1150 | 5 | NO | - | 1165.7 | 1234.2 | 1270.3 | 77.1 | 1146.5 | 1451.3 | 4.06 | 13.07 | 273.4 | 0/ 3 | 0.0 |
| 26/ 28 | 4.0 | 1125 | 0 | NO | - | 1138.9 | 1230.5 | 1268.8 | 77.2 | 1136.2 | 1452.1 | 4.03 | 13.02 | 270.8 | 0/ 0 | -25.0 |
| 26/ 29 | 4.0 | 1150 | 5 | NO | - | 1142.9 | 1232.6 | 1268.2 | 75.5 | 1142.4 | 1451.1 | 4.03 | 12.94 | 267.6 | 0/ 3 | 0.0 |
| 26/ 30 | 6.0 | 1375 | 5 | YES | 1.1 | 1353.7 | 1455.2 | 1490.5 | 77.1 | 1366.9 | 1728.3 | 6.01 | 12.84 | 263.1 | 2/ 3 | 125.0 |
| 26/ 31 | 6.0 | 1300 | 5 | YES | .7 | 1312.5 | 1380.7 | 1420.3 | 78.4 | 1295.8 | 1645.0 | 5.97 | 12.80 | 261.2 | 1/ 1 | 50.0 |
| 26/ 32 | 6.0 | 1250 | 5 | NO | - | 1270.4 | 1330.6 | 1365.9 | 74.7 | 1246.8 | 1583.1 | 6.08 | 12.77 | 259.9 | 0/ 2 | 0.0 |
| 26/ 33 | 6.0 | 1250 | 0 | NO | - | 1231.8 | 1338.4 | 1370.3 | 79.6 | 1245.6 | 1587.9 | 6.00 | 13.12 | 275.3 | 0/ 2 | 0.0 |
| 26/ 34 | 6.0 | 1250 | 5 | NO | - | 1225.6 | 1336.2 | 1368.0 | 78.5 | 1244.2 | 1583.0 | 6.00 | 13.09 | 274.2 | 0/ 2 | 0.0 |
| 26/ 35 | 6.0 | 1225 | 5 | NO | - | 1221.0 | 1328.5 | 1363.0 | 80.9 | 1235.8 | 1576.5 | 5.97 | 13.02 | 271.2 | 0/ 1 | -25.0 |
| 26/ 36 | 8.0 | 1375 | 5 | NO | - | 1359.6 | 1451.2 | 1498.6 | 79.3 | 1366.9 | 1751.2 | 7.96 | 12.94 | 267.3 | 0/ 1 | 125.0 |
| 26/ 37 | 8.0 | 1350 | 5 | YES | 2.4 | 1350.2 | 1444.5 | 1492.2 | 78.6 | 1361.8 | 1741.3 | 7.94 | 12.88 | 264.7 | 2/ 2 | 100.0 |
| 26/ 38 | 8.0 | 1350 | 5 | YES | 2.0 | 1388.0 | 1434.9 | 1478.4 | 80.1 | 1351.7 | 1725.1 | 7.99 | 12.84 | 263.0 | 2/ 2 | 100.0 |
| 26/ 39 | 8.0 | 1300 | 5 | NO | - | 1336.7 | 1383.8 | 1423.5 | 76.8 | 1299.3 | 1657.6 | 8.05 | 12.76 | 259.3 | 1/ 2 | 50.0 |
| 26/ 40 | 8.0 | 1300 | 5 | YES | 5.3 | 1324.4 | 1385.4 | 1425.5 | 76.9 | 1296.1 | 1664.3 | 7.97 | 13.10 | 274.5 | 1/ 2 | 50.0 |
| 26/ 41 | 8.0 | 1250 | 5 | NO | - | 1274.1 | 1333.5 | 1372.2 | 75.6 | 1242.3 | 1602.3 | 8.03 | 13.02 | 271.1 | 0/ 3 | 0.0 |
| 26/ 42 | 8.0 | 1250 | 5 | NO | - | 1272.6 | 1337.4 | 1377.8 | 76.0 | 1244.4 | 1608.9 | 7.94 | 12.98 | 269.0 | 0/ 3 | 0.0 |
| 26/ 43 | 8.0 | 1250 | 5 | NO | - | 1256.4 | 1333.8 | 1373.7 | 78.1 | 1240.6 | 1603.2 | 8.03 | 12.93 | 267.0 | 0/ 3 | 0.0 |
| 26/ 44 | 1.0 | 1200 | 5 | YES | 6.3 | 1204.5 | 1262.1 | 1274.6 | 78.1 | 1200.0 | 1449.0 | 1.06 | 12.84 | 263.0 | 2/ 2 | 300.0 |
| 26/ 45 | 1.0 | 1150 | 5 | YES | 6.0 | 1153.7 | 1202.3 | 1214.1 | 78.8 | 1144.9 | 1368.3 | 1.00 | 8.02 | 97.8 | 1/ 1 | 250.0 |
| 26/ 46 | 1.0 | 1100 | 5 | YES | 6.0 | 1118.1 | 1154.3 | 1163.5 | 80.4 | 1096.9 | 1309.7 | 1.04 | 8.01 | 97.6 | 1/ 1 | 200.0 |
| 26/ 47 | 1.0 | 1050 | 5 | YES | 6.3 | 1057.9 | 1110.4 | 1119.7 | 80.6 | 1051.3 | 1258.3 | 1.07 | 7.97 | 96.8 | 1/ 1 | 150.0 |
| 26/ 48 | 1.0 | 1000 | 5 | YES | 6.4 | 1008.3 | 1055.0 | 1065.2 | 83.1 | 1000.4 | 1193.5 | 1.10 | 7.95 | 96.2 | 1/ 1 | 100.0 |
| 26/ 49 | 1.0 | 950 | 5 | YES | 6.5 | 955.5 | 998.8 | 1007.9 | 81.0 | 944.0 | 1130.5 | 1.06 | 7.90 | 95.2 | 1/ 1 | 50.0 |
| 26/ 50 | 1.0 | 900 | 5 | NO | - | 907.3 | 948.5 | 956.3 | 81.5 | 838.5 | 1065.1 | .97 | 7.87 | 94.5 | 0/ 3 | 0.0 |
| 26/ 51 | 1.0 | 900 | 5 | NO | - | 904.2 | 943.0 | 955.4 | 79.6 | 894.3 | 1063.1 | 1.01 | 7.84 | 93.7 | 0/ 3 | 0.0 |
| 26/ 52 | 1.0 | 900 | 5 | NO | - | 909.4 | 946.5 | 963.3 | 81.5 | 897.5 | 1073.5 | 1.07 | 7.81 | 93.0 | 0/ 3 | 0.0 |
| 26/ 53 | 0.0 | 1200 | 5 | YES | 99.9 | 1174.5 | 1211.1 | 1268.1 | 79.5 | 1195.7 | 1399.0 | .14 | 7.75 | 91.6 | 1/ 2 | 200.0 |
| 26/ 54 | 0.0 | 1150 | 5 | YES | 99.9 | 1148.7 | 1165.3 | 1209.4 | 79.0 | 1140.6 | 1331.5 | .17 | 7.70 | 90.5 | 1/ 1 | 150.0 |
| 26/ 55 | 0.0 | 1100 | 5 | YES | 99.9 | 1097.2 | 1122.4 | 1164.1 | 80.8 | 1092.8 | 1280.3 | .14 | 7.67 | 89.9 | 1/ 1 | 100.0 |

# TABLE V-1

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

MIL-H-5606
BARE DUCT
SPRAY

| RUN/PT. | TEST CONDITIONS VEL | TEST CONDITIONS TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | THERMOCOUPLES T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | OVERALL LITES / ATTEMPT | OVERALL M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26/ 56 | 0.0 | 1050 | 0 | NO | - | 1041.9 | 1076.0 | 1122.4 | 81.6 | 1044.0 | 1228.1 | 0.00 | 7.60 | 88.4 | 1/ 1 | 50.0 |
| 26/ 57 | 0.0 | 1050 | 0 | NO | - | 1041.0 | 1074.5 | 1119.3 | 79.5 | 1041.7 | 1229.3 | 0.00 | 7.56 | 87.5 | 1/ 1 | 50.0 |
| 26/ 58 | 0.0 | 1075 | 5 | NO | - | 1092.7 | 1112.3 | 1155.7 | 63.1 | 1082.4 | 1275.1 | .19 | 8.14 | 100.7 | 0/ 1 | 75.0 |
| 26/ 59 | 0.0 | 1175 | 5 | YES | 99.9 | 1176.2 | 1219.5 | 1264.0 | 62.5 | 1183.5 | 1406.4 | 0.00 | 8.10 | 99.9 | 1/ 2 | 175.0 |
| 26/ 60 | 0.0 | 1050 | 5 | YES | 99.9 | 1044.0 | 1079.1 | 1111.0 | 69.0 | 1039.4 | 1229.8 | .14 | 8.04 | 98.3 | 1/ 1 | 50.0 |
| 26/ 61 | 0.0 | 1000 | 5 | NO | - | 991.3 | 1033.4 | 1067.7 | 64.6 | 987.7 | 1173.7 | .22 | 7.98 | 97.0 | 0/ 3 | 0.0 |
| 26/ 62 | 0.0 | 1000 | 5 | NO | - | 989.5 | 1029.3 | 1064.5 | 64.4 | 988.9 | 1173.3 | .21 | 7.88 | 94.7 | 0/ 3 | 0.0 |
| 26/ 63 | 0.0 | 1000 | 5 | NO | - | 1000.7 | 1032.5 | 1064.6 | 66.2 | 987.8 | 1182.0 | 0.00 | 7.86 | 94.2 | 0/ 3 | 0.0 |

# TABLE V-2

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

MIL-H-5606
DUCT & CLAMP
SPRAY

| RUN/PT. | --- TEST -- CONDITIONS VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | THERMOCOUPLES T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | --- OVERALL --- LITES / ATTEMPT | M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14/ 1 | 2.0 | 1300 | 0 | NO | - | 1356.8 | 1352.9 | 1354.5 | 1365.5 | 1298.9 | 1597.3 | 1.98 | 13.41 | 288.7 | 1/ 1 | 400.0 |
| 14/ 2 | 2.0 | 1300 | 5 | YES | 5.5 | 1355.2 | 1357.4 | 1346.5 | 1370.3 | 1302.2 | 1596.0 | 2.01 | 13.41 | 289.0 | 1/ 1 | 400.0 |
| 14/ 3 | 2.0 | 1150 | 5 | YES | 6.1 | 1189.4 | 1203.4 | 1191.9 | 1204.4 | 1143.3 | 1397.3 | 1.98 | 13.40 | 288.2 | 1/ 1 | 250.0 |
| 14/ 4 | 2.0 | 1100 | 5 | YES | 6.0 | 1140.1 | 1154.6 | 1156.6 | 1149.7 | 1096.1 | 1341.0 | 2.02 | 13.40 | 288.4 | 1/ 1 | 200.0 |
| 14/ 5 | 2.0 | 1050 | 5 | YES | 6.2 | 1091.1 | 1106.1 | 1115.2 | 1104.3 | 1050.6 | 1281.2 | 2.06 | 13.39 | 288.1 | 1/ 1 | 150.0 |
| 14/ 6 | 2.0 | 1000 | 5 | YES | 6.3 | 1033.6 | 1054.4 | 1073.3 | 1049.5 | 1004.3 | 1224.2 | 1.95 | 13.39 | 287.8 | 1/ 1 | 100.0 |
| 14/ 7 | 2.0 | 950 | 5 | NO | - | 982.2 | 1002.2 | 1020.2 | 995.3 | 918.2 | 1156.3 | 2.01 | 13.39 | 287.8 | 1/ 3 | 50.0 |
| 14/ 8 | 2.0 | 950 | 5 | YES | 6.6 | 989.1 | 1004.4 | 1038.5 | 990.1 | 949.9 | 1162.1 | 1.98 | 13.38 | 287.4 | 1/ 3 | 50.0 |
| 14/ 9 | 2.0 | 950 | 5 | NO | - | 979.4 | 993.9 | 1019.1 | 986.9 | 948.7 | 1148.3 | 2.00 | 13.39 | 287.7 | 1/ 3 | 50.0 |
| 14/ 10 | 2.0 | 900 | 5 | NO | - | 934.6 | 945.1 | 973.7 | 938.1 | 900.9 | 1096.7 | 2.04 | 13.37 | 286.9 | 0/ 3 | 0.0 |
| 14/ 12 | 2.0 | 900 | 5 | NO | - | 931.3 | 946.3 | 986.6 | 931.7 | 901.6 | 1101.2 | 2.00 | 13.36 | 286.3 | 0/ 3 | 0.0 |
| 14/ 13 | 2.0 | 900 | 5 | NO | - | 932.3 | 944.0 | 979.7 | 936.8 | 899.8 | 1096.0 | 1.98 | 13.35 | 285.9 | 0/ 3 | 0.0 |
| 14/ 14 | 4.0 | 1100 | 5 | NO | - | 1148.5 | 1156.4 | 1187.7 | 1152.1 | 1097.0 | 1371.5 | 3.97 | 13.36 | 286.3 | 0/ 1 | -100.0 |
| 14/ 15 | 4.0 | 1200 | 5 | NO | - | 1245.0 | 1263.5 | 1280.6 | 1258.9 | 1199.8 | 1493.4 | 3.95 | 13.34 | 285.7 | 0/16 | 0.0 |
| 14/ 16 | 4.0 | 1200 | 5 | NO | - | 1251.9 | 1264.0 | 1280.3 | 1263.0 | 1201.1 | 1500.3 | 4.09 | 8.27 | 103.9 | 0/16 | 0.0 |
| 14/ 17 | 4.0 | 1200 | 5 | NO | - | 1251.8 | 1273.0 | 1272.4 | 1279.2 | 1199.4 | 1500.2 | 3.96 | 3.85 | 25.3 | 0/16 | 0.0 |
| 14/ 18 | 4.0 | 1300 | 5 | YES | 5.6 | 1352.9 | 1359.7 | 1375.1 | 1375.4 | 1298.4 | 1618.1 | 4.08 | 3.84 | 25.2 | 2/ 2 | 100.0 |
| 14/ 19 | 4.0 | 1250 | 5 | NO | - | 1306.6 | 1315.4 | 1323.6 | 1336.9 | 1249.3 | 1561.1 | 4.05 | 3.80 | 24.6 | 3/ 7 | 50.0 |
| 14/ 20 | 4.0 | 1250 | 5 | NO | - | 1308.1 | 1319.0 | 1331.4 | 1329.5 | 1254.6 | 1565.5 | 4.05 | 3.81 | 24.7 | 3/ 7 | 50.0 |
| 14/ 21 | 4.0 | 1250 | 5 | NO | - | 1299.0 | 1309.5 | 1319.5 | 1328.1 | 1246.2 | 1549.0 | 3.92 | 3.79 | 24.6 | 3/ 7 | 50.0 |
| 14/ 22 | 4.0 | 1300 | 5 | YES | 5.7 | 1365.0 | 1365.2 | 1374.2 | 1380.0 | 1298.8 | 1620.3 | 3.96 | 13.14 | 276.6 | 2/ 2 | 100.0 |
| 14/ 23 | 4.0 | 1250 | 5 | YES | 5.9 | 1307.1 | 1316.2 | 1319.1 | 1335.7 | 1246.9 | 1553.3 | 3.92 | 13.03 | 271.6 | 3/ 7 | 50.0 |
| 14/ 24 | 4.0 | 1200 | 5 | NO | - | 1257.5 | 1263.9 | 1275.0 | 1264.6 | 1201.0 | 1494.0 | 4.03 | 12.97 | 268.7 | 0/16 | 0.0 |
| 14/ 25 | 4.0 | 1200 | 5 | NO | - | 1255.1 | 1272.6 | 1286.8 | 1293.1 | 1196.5 | 1506.0 | 3.95 | 12.94 | 267.4 | 0/16 | 0.0 |
| 14/ 26 | 4.0 | 1200 | 10 | NO | - | 1255.9 | 1273.5 | 1293.1 | 1296.8 | 1200.9 | 1500.8 | 3.94 | 12.87 | 264.3 | 0/16 | 0.0 |
| 14/ 27 | 6.0 | 1375 | 5 | YES | 5.5 | 1438.3 | 1451.8 | 1441.6 | 1455.8 | 1375.2 | 1744.5 | 6.08 | 12.95 | 267.8 | 1/ 1 | 50.0 |
| 14/ 28 | 6.0 | 1350 | 5 | YES | 10.2 | 1413.2 | 1426.5 | 1423.4 | 1466.0 | 1351.7 | 1715.4 | 5.83 | 12.92 | 266.4 | 2/ 2 | 25.0 |
| 14/ 29 | 6.0 | 1350 | 5 | YES | 7.5 | 1419.4 | 1428.2 | 1423.0 | 1479.3 | 1355.6 | 1716.8 | 6.01 | 12.89 | 265.3 | 2/ 2 | 25.0 |
| 14/ 30 | 6.0 | 1325 | 5 | NO | - | 1382.1 | 1398.5 | 1395.3 | 1442.8 | 1324.8 | 1678.3 | 6.00 | 12.88 | 264.8 | 0/ 3 | 0.0 |
| 14/ 31 | 6.0 | 1325 | 5 | NO | - | 1384.4 | 1417.5 | 1402.8 | 1454.9 | 1325.2 | 1687.1 | 6.09 | 12.86 | 264.1 | 0/ 3 | 0.0 |
| 14/ 32 | 6.0 | 1325 | 5 | NO | - | 1388.2 | 1405.5 | 1399.5 | 1441.5 | 1321.4 | 1676.3 | 5.94 | 12.85 | 263.6 | 0/ 3 | 0.0 |
| 14/ 33 | 3.0 | 1200 | 5 | YES | 6.4 | 1243.7 | 1263.0 | 1249.7 | 1252.8 | 1193.1 | 1474.5 | 2.99 | 12.85 | 263.4 | 3/ 3 | 175.0 |
| 14/ 34 | 3.0 | 1150 | 5 | NO | - | 1197.6 | 1211.6 | 1211.8 | 1205.2 | 1147.8 | 1425.7 | 2.98 | 12.81 | 261.6 | 1/ 4 | 125.0 |
| 14/ 35 | 3.0 | 1150 | 5 | NO | - | 1195.9 | 1211.7 | 1206.7 | 1204.5 | 1143.5 | 1411.8 | 3.02 | 12.83 | 262.7 | 1/ 4 | 125.0 |
| 14/ 36 | 3.0 | 1150 | 5 | NO | - | 1191.9 | 1216.0 | 1215.9 | 1223.6 | 1144.9 | 1415.2 | 2.96 | 12.82 | 262.0 | 1/ 4 | 125.0 |
| 14/ 37 | 1.0 | 1100 | 5 | YES | 6.9 | 1137.0 | 1131.1 | 1125.9 | 1128.6 | 1098.3 | 1310.1 | 1.08 | 12.82 | 262.3 | 1/ 4 | 150.0 |
| 14/ 38 | 1.0 | 1000 | 5 | NO | - | 1032.4 | 1027.3 | 1021.9 | 1027.9 | 994.9 | 1181.8 | 1.12 | 12.82 | 262.0 | 1/ 4 | 50.0 |
| 14/ 39 | 1.0 | 1000 | 5 | NO | - | 1032.6 | 1028.6 | 1033.3 | 1016.5 | 991.2 | 1190.9 | .96 | 12.80 | 261.4 | 1/ 4 | 50.0 |
| 14/ 40 | 1.0 | 1000 | 5 | NO | - | 1039.2 | 1022.7 | 1033.7 | 1032.5 | 1000.0 | 1190.3 | .98 | 12.81 | 261.5 | 1/ 4 | [illegible]0.0 |
| 14/ 41 | 1.0 | 1200 | 5 | NO | - | 1237.7 | 1224.4 | 1225.4 | 1229.2 | 1196.4 | 1424.8 | .96 | 4.02 | 27.6 | 2/ 4 | 250.0 |

# TABLE V-2

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

MIL-H-5606
DUCT & CLAMP
SPRAY

| RUN/PT. | --- TEST -- CONDITIONS VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | ----- THERMOCOUPLES ----- T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | --- OVERALL --- LITES / ATTEMPT | H.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14/ 42 | 1.0 | 1200 | 5 | YES | 6.7 | 1235.0 | 1222.6 | 1221.9 | 1245.8 | 1194.0 | 1421.7 | .91 | 3.99 | 27.2 | 2/ 4 | 250.0 |
| 14/ 43 | 1.0 | 1150 | 5 | NO | - | 1190.8 | 1183.6 | 1172.2 | 1187.9 | 1150.1 | 1369.6 | .98 | 4.02 | 27.6 | 2/ 5 | 200.0 |
| 14/ 44 | 1.0 | 1150 | 5 | NO | - | 1185.7 | 1176.6 | 1168.7 | 1189.7 | 1147.0 | 1358.8 | .98 | 3.98 | 27.1 | 2/ 5 | 200.0 |
| 14/ 45 | 1.0 | 1150 | 5 | NO | - | 1176.4 | 1174.9 | 1169.2 | 1185.9 | 1141.2 | 1364.5 | .99 | 3.99 | 27.2 | 2/ 5 | 200.0 |
| 14/ 46 | 1.0 | 1200 | 5 | YES | 6.2 | 1232.4 | 1224.2 | 1220.3 | 1236.8 | 1196.0 | 1423.5 | .98 | 3.07 | 15.5 | 2/ 4 | 250.0 |
| 14/ 47 | 1.0 | 1150 | 5 | YES | 6.8 | 1187.5 | 1171.1 | 1165.1 | 1183.8 | 1142.1 | 1360.5 | 1.06 | 3.07 | 15.4 | 2/ 5 | 200.0 |
| 14/ 48 | 1.0 | 1100 | 5 | NO | - | 1134.4 | 1127.7 | 1117.5 | 1130.9 | 1094.0 | 1302.4 | 1.04 | 3.05 | 15.3 | 1/ 4 | 150.0 |
| 14/ 49 | 1.0 | 1100 | 5 | NO | - | 1141.3 | 1142.3 | 1129.6 | 1140.8 | 1095.4 | 1313.4 | .99 | 3.06 | 15.4 | 1/ 4 | 150.0 |
| 14/ 50 | 1.0 | 1100 | 5 | NO | - | 1135.8 | 1142.1 | 1134.0 | 1150.7 | 1095.2 | 1320.7 | .95 | 3.05 | 15.3 | 1/ 4 | 150.0 |
| 14/ 51 | 1.0 | 1200 | 5 | NO | - | 1230.5 | 1223.8 | 1219.8 | 1227.9 | 1192.4 | 1419.8 | 1.01 | 2.39 | 7.5 | 2/ 4 | 250.0 |
| 14/ 52 | 0.0 | 1200 | 5 | YES | 7.3 | 1232.8 | 1189.8 | 1216.4 | 1217.4 | 1197.9 | 1401.9 | 0.00 | 12.93 | 266.8 | 1/ 1 | 125.0 |
| 14/ 53 | 0.0 | 1150 | 5 | YES | 99.9 | 1180.0 | 1145.0 | 1162.9 | 1167.2 | 1144.0 | 1335.0 | 0.00 | 12.91 | 266.0 | 1/ 1 | 75.0 |
| 14/ 54 | 0.0 | 1100 | 5 | NO | - | 1121.6 | 1083.2 | 1115.5 | 1115.3 | 1093.5 | 1272.1 | .17 | 12.91 | 266.2 | 1/ 3 | 25.0 |
| 14/ 55 | 0.0 | 1100 | 5 | NO | - | 1128.8 | 1097.6 | 1127.1 | 1117.3 | 1093.2 | 1284.8 | .20 | 12.89 | 265.2 | 1/ 3 | 25.0 |
| 14/ 56 | 0.0 | 1100 | 5 | YES | 99.9 | 1128.4 | 1094.7 | 1135.6 | 1119.3 | 1092.2 | 1286.1 | .17 | 12.89 | 265.3 | 1/ 3 | 25.0 |
| 14/ 57 | 0.0 | 1075 | 5 | NO | - | 1099.6 | 1069.5 | 1099.8 | 1091.9 | 1075.8 | 1253.0 | 0.00 | 12.91 | 266.3 | 0/ 3 | 0.0 |
| 14/ 58 | 0.0 | 1075 | 5 | NO | - | 1103.4 | 1075.9 | 1105.1 | 1093.9 | 1076.0 | 1255.1 | 0.00 | 12.91 | 266.3 | 0/ 3 | 0.0 |
| 14/ 59 | 0.0 | 1075 | 5 | NO | - | 1101.4 | 1072.2 | 1106.6 | 1088.6 | 1071.7 | 1253.4 | 0.00 | 12.91 | 266.1 | 0/ 3 | 0.0 |
| 14/ 60 | 1.0 | 1150 | 5 | YES | 6.3 | 1174.1 | 1165.4 | 1171.4 | 1168.1 | 1138.8 | 1352.6 | .92 | 12.92 | 266.3 | 2/ 5 | 200.0 |
| 14/ 61 | 1.0 | 1050 | 5 | YES | 6.6 | 1086.7 | 1074.8 | 1076.9 | 1080.6 | 1050.3 | 1247.9 | 1.02 | 12.92 | 266.4 | 1/ 1 | 100.0 |
| 14/ 62 | 1.0 | 1000 | 5 | YES | 3.4 | 1032.3 | 1018.1 | 1047.2 | 1026.7 | 990.0 | 1179.6 | .92 | 12.93 | 266.9 | 1/ 4 | 50.0 |
| 14/ 63 | 1.0 | 950 | 5 | NO | - | 969.0 | 960.5 | 978.0 | 963.3 | 941.2 | 1101.7 | .99 | 12.92 | 266.4 | 0/ 3 | 0.0 |
| 14/ 64 | 1.0 | 950 | 5 | NO | - | 974.6 | 977.6 | 981.3 | 976.0 | 949.5 | 1116.3 | 1.04 | 12.91 | 266.2 | 0/ 3 | 0.0 |
| 14/ 65 | 1.0 | 950 | 5 | NO | - | 973.7 | 968.2 | 987.6 | 969.9 | 946.4 | 1114.4 | .98 | 12.91 | 265.9 | 0/ 3 | 0.0 |
| 14/ 66 | 3.0 | 1200 | 5 | YES | 5.8 | 1237.5 | 1253.6 | 1261.3 | 1241.6 | 1194.8 | 1474.9 | 2.99 | 12.92 | 266.4 | 3/ 3 | 175.0 |
| 14/ 67 | 3.0 | 1150 | 5 | YES | 6.4 | 1198.2 | 1214.5 | 1218.5 | 1206.4 | 1151.3 | 1421.1 | 3.01 | 12.91 | 266.3 | 1/ 4 | 125.0 |
| 14/ 68 | 3.0 | 1125 | 5 | NO | - | 1169.7 | 1195.7 | 1199.0 | 1173.2 | 1129.5 | 1394.1 | 2.99 | 12.91 | 266.3 | 1/ 4 | 100.0 |
| 14/ 69 | 3.0 | 1125 | 5 | NO | - | 1171.1 | 1200.2 | 1203.3 | 1187.5 | 1126.5 | 1393.0 | 3.03 | 12.90 | 265.7 | 1/ 4 | 100.0 |
| 14/ 70 | 3.0 | 1125 | 5 | NO | - | 1184.9 | 1194.4 | 1211.4 | 1186.3 | 1133.5 | 1399.7 | 3.01 | 12.90 | 265.7 | 1/ 4 | 100.0 |
| 14/ 71 | 3.0 | 1200 | 5 | YES | 6.0 | 1244.6 | 1262.3 | 1263.0 | 1232.6 | 1195.2 | 1472.8 | 2.98 | 14.89 | 384.7 | 3/ 3 | 175.0 |
| 14/ 72 | 3.0 | 1125 | 5 | YES | 5.9 | 1167.2 | 1194.4 | 1194.6 | 1165.5 | 1123.2 | 1385.3 | 3.03 | 14.90 | 385.6 | 1/ 4 | 100.0 |
| 14/ 73 | 3.0 | 1075 | 5 | YES | 5.9 | 1106.1 | 1122.7 | 1140.9 | 1118.6 | 1069.8 | 1319.8 | 2.97 | 14.89 | 384.6 | 1/ 1 | 50.0 |
| 14/ 74 | 3.0 | 1025 | 5 | NO | - | 1054.9 | 1077.3 | 1090.1 | 1058.7 | 1015.9 | 1251.0 | 3.00 | 14.89 | 383.7 | 0/ 3 | 0.0 |
| 14/ 75 | 3.0 | 1025 | 5 | NO | - | 1050.3 | 1083.8 | 1103.2 | 1067.3 | 1018.0 | 1260.4 | 3.03 | 14.88 | 383.1 | 0/ 3 | 0.0 |
| 14/ 76 | 3.0 | 1025 | 5 | NO | - | 1059.1 | 1095.5 | 1116.3 | 1070.3 | 1019.6 | 1264.3 | 3.01 | 14.88 | 382.7 | 0/ 3 | 0.0 |
| 14/ 77 | 4.0 | 1250 | 5 | YES | 99.9 | 1303.4 | 1322.2 | 1339.1 | 1297.0 | 1246.7 | 1555.8 | 3.98 | 14.88 | 382.8 | 3/ 7 | 50.0 |
| 14/ 78 | 4.0 | 1250 | 5 | NO | - | 1299.6 | 1325.3 | 1308.0 | 1290.2 | 1247.9 | 1553.4 | 4.08 | 14.82 | 374.7 | 3/ 7 | 50.0 |
| 14/ 79 | 4.0 | 1250 | 5 | YES | 6.8 | 1302.5 | 1335.1 | 1316.4 | 1301.9 | 1247.0 | 1557.8 | 4.07 | 14.82 | 375.0 | 3/ 7 | 50.0 |
| 14/ 80 | 4.0 | 1200 | 5 | NO | - | 1244.4 | 1262.5 | 1263.4 | 1231.5 | 1193.7 | 1490.5 | 4.08 | 14.81 | 374.1 | 0/16 | 0.0 |
| 14/ 81 | 4.0 | 1200 | 5 | NO | - | 1246.1 | 1266.8 | 1269.5 | 1245.6 | 1196.3 | 1492.7 | 4.03 | 14.81 | 373.8 | 0/16 | 0.0 |

# TABLE V-2



F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

MIL-H-5606
DUCT & CLAMP
SPRAY

| RUN/PT. | --- TEST -- CONDITIONS VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | ---- THERMOCOUPLES ---- T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | --- OVERALL --- LITES / ATTEMPT | M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14/ 82 | 4.0 | 1200 | 5 | NO | - | 1260.2 | 1277.5 | 1271.5 | 1243.7 | 1194.8 | 1490.6 | 4.02 | 14.81 | 373.5 | 0/16 | 0.0 |
| 14/ 83 | 4.0 | 1200 | 5 | NO | - | 1244.5 | 1266.3 | 1262.1 | 1234.5 | 1195.6 | 1493.7 | 4.03 | 13.95 | 315.5 | 0/15 | 0.0 |
| 14/ 84 | 4.0 | 1200 | 5 | NO | - | 1241.1 | 1271.8 | 1266.2 | 1240.4 | 1193.0 | 1492.1 | 3.95 | 13.88 | 311.7 | 0/16 | 0.0 |
| 14/ 85 | 4.0 | 1200 | 5 | NO | - | 1247.2 | 1265.8 | 1269.3 | 1248.9 | 1190.6 | 1499.9 | 3.95 | 13.81 | 308.2 | 0/16 | 0.0 |
| 14/ 87 | 4.0 | 1200 | 5 | NO | - | 1245.0 | 1265.7 | 1261.5 | 1240.4 | 1195.0 | 1500.2 | 3.91 | 11.84 | 221.0 | 0/16 | 0.0 |
| 14/ 88 | 4.0 | 1200 | 5 | NO | - | 1252.5 | 1279.0 | 1275.5 | 1260.3 | 1196.4 | 1503.6 | 3.96 | 11.81 | 219.6 | 0/16 | 0.0 |
| 14/ 89 | 4.0 | 1200 | 5 | NO | - | 1253.6 | 1273.5 | 1274.8 | 1257.2 | 1191.6 | 1505.2 | 4.02 | 11.79 | 218.8 | 0/16 | 0.0 |
| 14/ 92 | 4.0 | 1325 | 5 | YES | 12.3 | 1380.6 | 1397.9 | 1394.7 | 1392.2 | 1325.8 | 1660.4 | 4.02 | 9.87 | 140.6 | 1/ 1 | 125.0 |
| 14/ 94 | 4.0 | 1200 | 5 | NO | - | 1239.0 | 1267.0 | 1261.5 | 1228.2 | 1190.5 | 1491.4 | 4.06 | 9.73 | 144.2 | 0/16 | 0.0 |
| 14/ 96 | 4.0 | 1050 | 5 | NO | - | 1096.3 | 1103.7 | 1118.6 | 1084.3 | 1048.6 | 1314.0 | 4.07 | 9.64 | 141.6 | 0/ 1 | -150.0 |
| 14/ 97 | 4.0 | 1000 | 5 | NO | - | 1035.2 | 1070.6 | 1074.1 | 1029.2 | 998.3 | 1252.7 | 4.09 | 9.62 | 140.9 | 0/ 2 | -200.0 |
| 14/ 98 | 4.0 | 1000 | 5 | NO | - | 1038.6 | 1058.9 | 1085.9 | 1027.6 | 998.9 | 1263.3 | 4.00 | 9.59 | 139.9 | 0/ 2 | -200.0 |

# TABLE V-3

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

MIL-H-5606
BARE DUCT
DRIP

| RUN/PT. | --- TEST -- CONDITIONS VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | THERMOCOUPLES T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | --- OVERALL --- LITES / ATTEMPT | H.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6/ 1 | 2.0 | 1150 | 10 | NO | - | 1160.7 | 1166.2 | 1213.8 | 1169.9 | 1147.3 | 1350.5 | 2.01 | .30 | 80.0 | 1/ 2 | 150.0 |
| 6/ 2 | 2.0 | 1200 | 10 | NO | - | 1209.4 | 1217.3 | 1262.2 | 1214.8 | 1190.6 | 1401.7 | 1.96 | .30 | 80.0 | 3/ 4 | 200.0 |
| 6/ 4 | 2.0 | 1200 | 10 | YES | 2.7 | 1216.9 | 1226.3 | 1260.9 | 1214.4 | 1191.6 | 1403.0 | 2.01 | 1.22 | 110.0 | 3/ 4 | 200.0 |
| 6/ 5 | 2.0 | 1150 | 10 | YES | 2.2 | 1165.6 | 1180.5 | 1208.8 | 1167.5 | 1142.4 | 1336.5 | 2.01 | 1.22 | 110.0 | 1/ 2 | 150.0 |
| 6/ 6 | 2.0 | 1125 | 10 | YES | 3.1 | 1145.1 | 1149.8 | 1191.3 | 1141.0 | 1123.9 | 1318.3 | 1.93 | 1.22 | 110.0 | 1/ 1 | 125.0 |
| 6/ 7 | 2.0 | 1075 | 10 | YES | 6.2 | 1090.3 | 1101.3 | 1138.5 | 1092.8 | 1069.0 | 1258.0 | 1.98 | 1.22 | 110.0 | 2/ 2 | 75.0 |
| 6/ 8 | 2.0 | 1050 | 10 | YES | 5.6 | 1066.6 | 1084.1 | 1120.0 | 1078.2 | 1051.0 | 1243.3 | 2.01 | 1.22 | 110.0 | 2/ 2 | 50.0 |
| 6/ 9 | 2.0 | 1025 | 10 | NO | - | 1032.9 | 1046.0 | 1090.8 | 1044.1 | 1019.3 | 1209.1 | 2.07 | 1.22 | 110.0 | 1/ 3 | 25.0 |
| 6/ 10 | 2.0 | 1025 | 10 | YES | 5.6 | 1039.5 | 1054.3 | 1098.7 | 1052.0 | 1019.2 | 1194.3 | 2.02 | 1.22 | 110.0 | 1/ 3 | 25.0 |
| 6/ 11 | 2.0 | 1000 | 10 | NO | - | 1010.5 | 1019.7 | 1065.6 | 1018.9 | 991.1 | 1162.6 | 2.05 | 1.22 | 110.0 | 0/ 3 | 0.0 |
| 6/ 12 | 4.0 | 1175 | 10 | NO | - | 1206.8 | 1240.1 | 1271.5 | 1228.6 | 1186.4 | 1424.8 | 3.94 | 1.22 | 110.0 | 2/ 3 | 75.0 |
| 6/ 13 | 4.0 | 1225 | 10 | YES | 2.2 | 1260.6 | 1285.7 | 1321.9 | 1276.0 | 1237.1 | 1474.4 | 3.98 | 1.22 | 110.0 | 1/ 1 | 125.0 |
| 6/ 14 | 4.0 | 1200 | 10 | NO | - | 1228.0 | 1251.9 | 1289.8 | 1248.8 | 1210.9 | 1448.5 | 3.97 | 1.22 | 110.0 | 2/ 3 | 100.0 |
| 6/ 15 | 4.0 | 1200 | 10 | YES | 4.1 | 1231.9 | 1251.6 | 1293.4 | 1243.8 | 1209.5 | 1447.6 | 3.99 | 2.01 | 130.0 | 2/ 3 | 100.0 |
| 6/ 17 | 4.0 | 1200 | 10 | YES | 6.7 | 1219.5 | 1235.8 | 1274.4 | 1223.7 | 1190.3 | 1424.1 | 3.98 | 2.01 | 130.0 | 2/ 3 | 100.0 |
| 6/ 18 | 4.0 | 1175 | 10 | YES | 11.0 | 1203.8 | 1222.6 | 1263.7 | 1210.9 | 1177.1 | 1405.1 | 4.02 | 2.01 | 130.0 | 2/ 3 | 75.0 |
| 6/ 19 | 4.0 | 1125 | 0 | NO | - | 1155.3 | 1165.3 | 1217.4 | 1167.7 | 1129.8 | 1347.0 | 3.98 | 2.01 | 130.0 | 0/ 0 | 25.0 |
| 6/ 20 | 6.0 | 1300 | 10 | YES | 8.3 | 1322.3 | 1345.6 | 1383.9 | 1333.1 | 1290.4 | 1573.9 | 5.97 | 2.01 | 130.0 | 1/ 1 | 100.0 |
| 6/ 21 | 6.0 | 1250 | 10 | NO | - | 1289.5 | 1310.9 | 1353.3 | 1300.2 | 1259.7 | 1528.2 | 5.94 | 2.72 | 150.0 | 1/ 2 | 50.0 |
| 6/ 22 | 6.0 | 1275 | 10 | NO | - | 1286.3 | 1309.2 | 1357.0 | 1304.5 | 1268.8 | 1542.7 | 6.04 | 2.72 | 150.0 | 1/ 2 | 75.0 |
| 6/ 23 | 8.0 | 1400 | 10 | YES | 8.4 | 1418.4 | 1456.6 | 1491.5 | 1437.8 | 1394.0 | 1730.9 | 7.92 | 2.72 | 150.0 | 1/ 1 | 150.0 |
| 6/ 24 | 8.0 | 1350 | 10 | NO | - | 1390.4 | 1413.7 | 1459.9 | 1406.6 | 1360.5 | 1690.4 | 8.01 | 2.72 | 150.0 | 3/ 5 | 100.0 |
| 6/ 25 | 8.0 | 1350 | 10 | YES | 8.5 | 1394.2 | 1419.7 | 1456.0 | 1405.9 | 1359.7 | 1686.0 | 7.87 | 2.72 | 150.0 | 3/ 5 | 100.0 |
| 6/ 26 | 8.0 | 1350 | 10 | YES | 9.9 | 1381.2 | 1420.2 | 1462.7 | 1410.7 | 1361.5 | 1692.9 | 7.92 | 2.72 | 150.0 | 3/ 5 | 100.0 |
| 6/ 27 | 8.0 | 1350 | 10 | NO | - | 1365.1 | 1390.7 | 1439.4 | 1383.1 | 1339.1 | 1663.7 | 8.05 | 2.72 | 150.0 | 3/ 5 | 100.0 |
| 6/ 28 | 0.0 | 1300 | 10 | YES | .4 | 1308.4 | 1262.0 | 1337.8 | 1255.8 | 1292.2 | 1484.9 | 0.00 | 2.72 | 150.0 | 1/ 1 | 300.0 |
| 6/ 29 | 0.0 | 1225 | 10 | YES | 1.4 | 1235.1 | 1194.3 | 1264.8 | 1181.1 | 1217.2 | 1399.7 | 0.00 | 2.72 | 150.0 | 1/ 1 | 225.0 |
| 6/ 30 | 0.0 | 1175 | 10 | YES | .5 | 1203.5 | 1153.3 | 1228.6 | 1149.3 | 1187.0 | 1343.8 | 0.00 | 2.72 | 150.0 | 2/ 2 | 175.0 |
| 6/ 31 | 0.0 | 1175 | 10 | YES | 5.5 | 1204.9 | 1155.6 | 1226.5 | 1145.8 | 1179.8 | 1348.6 | 0.00 | 2.72 | 150.0 | 2/ 2 | 175.0 |
| 6/ 32 | 0.0 | 1150 | 10 | YES | 3.6 | 1183.2 | 1133.3 | 1208.4 | 1123.1 | 1160.1 | 1325.1 | 0.00 | 2.72 | 150.0 | 1/ 1 | 150.0 |
| 6/ 33 | 0.0 | 1125 | 10 | YES | 11.2 | 1162.7 | 1104.2 | 1187.0 | 1102.9 | 1136.3 | 1293.0 | 0.00 | 2.72 | 150.0 | 2/ 2 | 125.0 |
| 6/ 34 | 0.0 | 1100 | 10 | NO | - | 1135.2 | 1078.3 | 1157.0 | 1079.1 | 1108.9 | 1250.3 | 0.00 | 2.72 | 150.0 | 1/ 2 | 100.0 |
| 6/ 35 | 1.0 | 1100 | 10 | YES | 1.9 | 1129.9 | 1121.0 | 1158.5 | 1111.2 | 1106.6 | 1281.8 | .84 | 2.72 | 150.0 | 2/ 2 | 150.0 |
| 6/ 36 | 1.0 | 1025 | 10 | YES | 2.2 | 1033.9 | 1031.9 | 1068.0 | 1014.6 | 1022.1 | 1160.5 | .97 | 2.72 | 150.0 | 2/ 2 | 75.0 |
| 6/ 37 | 1.0 | 975 | 0 | NO | - | 980.4 | 980.8 | 1015.1 | 965.7 | 970.8 | 1100.8 | 1.00 | 2.72 | 150.0 | 0/ 0 | 25.0 |
| 27/ 1 | 2.0 | 1200 | 10 | YES | .8 | 1226.2 | 1283.4 | 1294.7 | 68.3 | 1200.5 | 1475.0 | 2.01 | 1.80 | 125.0 | 3/ 4 | 200.0 |
| 27/ 2 | 2.0 | 1025 | 10 | NO | - | 1054.2 | 1112.4 | 1132.6 | 65.5 | 1034.3 | 1268.5 | 2.05 | 1.80 | 125.0 | 1/ 3 | 25.0 |
| 27/ 3 | 4.0 | 1175 | 10 | YES | .4 | 1216.8 | 1274.0 | 1312.9 | 66.0 | 1185.1 | 1486.9 | 4.01 | 1.80 | 125.0 | 2/ 3 | 75.0 |
| 27/ 4 | 4.0 | 1150 | 10 | YES | 1.7 | 1170.4 | 1229.5 | 1260.2 | 69.2 | 1139.3 | 1432.8 | 4.04 | 1.80 | 125.0 | 1/ 1 | 50.0 |
| 27/ 5 | 4.0 | 1100 | 10 | NO | - | 1118.0 | 1179.6 | 1212.3 | 68.6 | 1091.9 | 1373.0 | 4.02 | 1.80 | 125.0 | 0/ 3 | 0.0 |

# TABLE V-3

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

MIL-H-5606
BARE DUCT
DRIP

| RUN/PT. | TEST CONDITIONS VEL | TEST CONDITIONS TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | THERMOCOUPLES T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | OVERALL LITES / ATTEMPT | OVERALL H.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 27/ 6 | 4.0 | 1100 | 10 | NO | - | 1109.5 | 1176.5 | 1203.6 | 68.7 | 1088.0 | 1364.7 | 4.00 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 27/ 7 | 4.0 | 1100 | 10 | NO | - | 1109.5 | 1176.7 | 1205.1 | 65.2 | 1088.0 | 1367.0 | 4.03 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 27/ 8 | 6.0 | 1275 | 10 | YES | .4 | 1323.1 | 1373.6 | 1417.7 | 69.0 | 1282.3 | 1635.0 | 5.97 | 1.80 | 125.0 | 1/ 2 | 75.0 |
| 27/ 9 | 6.0 | 1250 | 10 | YES | .5 | 1281.2 | 1330.9 | 1376.4 | 67.7 | 1241.1 | 1579.0 | 5.99 | 1.80 | 125.0 | 1/ 2 | 50.0 |
| 27/ 10 | 6.0 | 1200 | 10 | NO | - | 1232.6 | 1291.3 | 1331.5 | 73.0 | 1194.9 | 1527.6 | 6.00 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 27/ 11 | 6.0 | 1200 | 10 | NO | - | 1220.1 | 1279.0 | 1318.2 | 69.4 | 1188.0 | 1511.5 | 6.01 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 27/ 12 | 6.0 | 1200 | 10 | NO | - | 1223.7 | 1281.2 | 1322.9 | 70.0 | 1188.0 | 1516.4 | 5.95 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 27/ 13 | 8.0 | 1350 | 10 | YES | .4 | 1390.8 | 1426.5 | 1477.0 | 70.0 | 1341.2 | 1715.9 | 7.98 | 1.80 | 125.0 | 3/ 5 | 100.0 |
| 27/ 14 | 8.0 | 1275 | 10 | YES | .4 | 1333.2 | 1375.2 | 1282.4 | 65.2 | 1286.9 | 1651.4 | 8.03 | 1.80 | 125.0 | 1/ 1 | 25.0 |
| 27/ 15 | 8.0 | 1250 | 10 | NO | - | 1276.5 | 1323.0 | 1373.4 | 71.3 | 1238.0 | 1586.9 | 8.01 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 27/ 16 | 8.0 | 1250 | 10 | NO | - | 1280.3 | 1327.3 | 1379.1 | 70.5 | 1238.0 | 1593.5 | 7.94 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 27/ 17 | 8.0 | 1250 | 10 | NO | - | 1284.8 | 1334.6 | 1381.5 | 70.1 | 1242.9 | 1601.6 | 7.95 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 27/ 18 | 8.0 | 1300 | 10 | NO | - | 1336.7 | 1377.8 | 1328.7 | 72.1 | 1290.5 | 1656.7 | 7.96 | .88 | 100.0 | 0/ 1 | 50.0 |
| 27/ 19 | 2.0 | 1300 | 10 | YES | .3 | 1322.3 | 1366.7 | 1401.4 | 71.0 | 1290.4 | 1590.5 | 2.03 | .88 | 100.0 | 1/ 1 | 300.0 |
| 27/ 20 | 2.0 | 1200 | 10 | YES | .7 | 1220.7 | 1271.5 | 1299.9 | 70.4 | 1194.3 | 1462.6 | 1.92 | .88 | 100.0 | 3/ 4 | 200.0 |
| 27/ 21 | 2.0 | 1075 | 10 | YES | 2.5 | 1104.9 | 1168.4 | 1181.4 | 70.4 | 1083.5 | 1322.4 | 2.01 | .88 | 100.0 | 2/ 2 | 75.0 |
| 27/ 22 | 2.0 | 1050 | 10 | YES | 2.3 | 1063.6 | 1118.9 | 1146.2 | 68.2 | 1039.9 | 1274.0 | 2.01 | .88 | 100.0 | 2/ 2 | 50.0 |
| 27/ 23 | 2.0 | 975 | 10 | NO | - | 1005.3 | 1067.7 | 1090.9 | 66.7 | 983.6 | 1205.6 | 2.00 | .88 | 100.0 | 0/ 1 | -25.0 |
| 27/ 24 | 2.0 | 1000 | 10 | NO | - | 1010.0 | 1073.1 | 1094.6 | 67.9 | 990.9 | 1217.5 | 2.02 | .88 | 100.0 | 0/ 3 | 0.0 |
| 27/ 25 | 2.0 | 1000 | 10 | NO | - | 1008.7 | 1073.3 | 1097.0 | 66.1 | 989.8 | 1217.7 | 2.03 | .88 | 100.0 | 0/ 3 | 0.0 |
| 27/ 26 | 1.0 | 1100 | 10 | YES | 2.1 | 1109.3 | 1148.2 | 1167.6 | 72.4 | 1090.7 | 1295.8 | 1.01 | .88 | 100.0 | 2/ 2 | 150.0 |
| 27/ 27 | 1.0 | 1025 | 10 | YES | 6.0 | 1057.3 | 1091.8 | 1111.4 | 68.7 | 1036.8 | 1233.9 | .96 | .88 | 100.0 | 2/ 2 | 75.0 |
| 27/ 28 | 1.0 | 1000 | 10 | NO | - | 1007.2 | 1044.6 | 1063.5 | 69.9 | 994.8 | 1170.4 | 1.00 | .88 | 100.0 | 1/ 2 | 50.0 |
| 27/ 29 | 1.0 | 1000 | 10 | YES | 6.0 | 1004.4 | 1041.2 | 1063.5 | 72.9 | 988.3 | 1167.9 | 1.02 | .88 | 100.0 | 1/ 2 | 50.0 |
| 27/ 30 | 1.0 | 950 | 10 | NO | - | 960.2 | 996.6 | 1014.2 | 73.3 | 944.3 | 1115.4 | 1.01 | .88 | 100.0 | 0/ 3 | 0.0 |
| 27/ 31 | 1.0 | 950 | 10 | NO | - | 954.7 | 988.8 | 1013.9 | 73.4 | 938.0 | 1109.6 | 1.03 | .88 | 100.0 | 0/ 3 | 0.0 |
| 27/ 32 | 1.0 | 950 | 10 | NO | - | 956.8 | 992.0 | 1018.8 | 74.8 | 943.5 | 1113.7 | 1.00 | .88 | 100.0 | 0/ 3 | 0.0 |
| 27/ 33 | 0.0 | 1125 | 10 | YES | 2.1 | 1157.0 | 1153.8 | 1227.4 | 72.5 | 1136.4 | 1329.8 | .14 | .88 | 100.0 | 2/ 2 | 125.0 |
| 27/ 34 | 0.0 | 1100 | 10 | YES | 2.1 | 1119.0 | 1137.5 | 1194.8 | 70.9 | 1100.2 | 1295.5 | 0.00 | .88 | 100.0 | 1/ 2 | 100.0 |
| 27/ 35 | 0.0 | 1050 | 10 | YES | 2.6 | 1068.6 | 1087.7 | 1144.2 | 72.3 | 1048.5 | 1233.9 | .10 | .88 | 100.0 | 1/ 1 | 50.0 |
| 27/ 36 | 0.0 | 1000 | 10 | NO | - | 1005.8 | 1021.9 | 1077.3 | 72.2 | 989.1 | 1155.2 | .20 | .88 | 100.0 | 0/ 3 | 0.0 |
| 27/ 37 | 0.0 | 1000 | 10 | NO | - | 1005.8 | 1016.9 | 1078.0 | 71.7 | 991.0 | 1153.1 | .24 | .88 | 100.0 | 0/ 3 | 0.0 |
| 27/ 38 | 0.0 | 1000 | 10 | NO | - | 1003.8 | 1012.8 | 1074.4 | 71.0 | 991.2 | 1149.4 | .20 | .88 | 100.0 | 0/ 3 | 0.0 |
| 27/ 39 | .5 | 1000 | 10 | NO | - | 1009.6 | 1019.1 | 1081.1 | 71.9 | 996.5 | 1159.5 | .26 | .88 | 100.0 | 0/ 1 | 1000.0 |

# TABLE V-4

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

MIL-H-5606
DUCT & CLAMP
DRIP

| RUN/PT. | --- TEST -- CONDITIONS VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | THERMOCOUPLES T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | --- OVERALL --- LITES / ATTEMPT | M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13/ 1 | 2.0 | 1300 | 10 | YES | .3 | 1344.1 | 1346.6 | 1349.8 | 1364.0 | 1302.0 | 1578.1 | 2.07 | 1.80 | 125.0 | 1/ 1 | 650.0 |
| 13/ 2 | 2.0 | 1200 | 10 | YES | .5 | 1235.1 | 1240.0 | 1237.2 | 1258.1 | 1198.0 | 1441.2 | 2.01 | 1.80 | 125.0 | 1/ 1 | 550.0 |
| 13/ 3 | 2.0 | 1100 | 10 | YES | 1.0 | 1128.8 | 1144.6 | 1140.2 | 1149.8 | 1098.9 | 1317.9 | 2.01 | 1.80 | 125.0 | 1/ 1 | 450.0 |
| 13/ 4 | 2.0 | 1000 | 10 | YES | 1.4 | 1032.1 | 1039.1 | 1051.2 | 1049.5 | 999.1 | 1205.3 | 2.00 | 1.80 | 125.0 | 2/ 2 | 350.0 |
| 13/ 5 | 2.0 | 950 | 10 | YES | 1.4 | 976.3 | 984.2 | 1007.9 | 988.8 | 944.0 | 1144.9 | 2.07 | 1.80 | 125.0 | 1/ 1 | 300.0 |
| 13/ 6 | 2.0 | 900 | 10 | YES | 1.9 | 923.6 | 942.6 | 967.5 | 940.8 | 903.0 | 1091.0 | 2.06 | 1.80 | 125.0 | 2/ 2 | 250.0 |
| 13/ 7 | 2.0 | 850 | 10 | YES | 2.1 | 871.3 | 886.8 | 916.5 | 883.7 | 847.5 | 1025.1 | 2.03 | 1.80 | 125.0 | 1/ 1 | 200.0 |
| 13/ 8 | 2.0 | 800 | 10 | YES | 2.4 | 825.9 | 839.1 | 874.0 | 837.4 | 803.5 | 977.7 | 1.97 | 1.80 | 125.0 | 2/ 2 | 150.0 |
| 13/ 9 | 2.0 | 750 | 10 | YES | 2.6 | 764.6 | 778.8 | 817.9 | 773.8 | 748.0 | 906.1 | 1.96 | 1.80 | 125.0 | 1/ 1 | 100.0 |
| 13/ 10 | 2.0 | 700 | 10 | YES | 2.9 | 713.7 | 726.3 | 768.2 | 723.0 | 697.1 | 835.0 | 2.03 | 1.80 | 125.0 | 1/ 5 | 50.0 |
| 13/ 11 | 2.0 | 650 | 10 | NO | - | 659.2 | 670.2 | 710.7 | 667.6 | 646.6 | 772.4 | 2.02 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 13/ 12 | 2.0 | 650 | 10 | NO | - | 666.3 | 672.1 | 714.0 | 664.6 | 652.3 | 790.8 | 1.99 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 13/ 13 | 2.0 | 650 | 10 | NO | - | 657.6 | 664.3 | 730.3 | 635.6 | 651.9 | 794.5 | 2.08 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 13/ 14 | 2.0 | 700 | 10 | NO | - | 709.3 | 718.9 | 761.2 | 719.8 | 697.8 | 839.3 | 2.03 | 1.80 | 125.0 | 1/ 5 | 50.0 |
| 13/ 15 | 2.0 | 1000 | 10 | YES | 1.1 | 1026.8 | 1030.2 | 1083.0 | 1033.5 | 1000.2 | 1211.4 | 1.99 | 1.80 | 125.0 | 2/ 2 | 350.0 |
| 13/ 16 | 2.0 | 900 | 10 | YES | 1.2 | 926.0 | 933.1 | 973.9 | 933.6 | 904.4 | 1082.6 | 2.08 | 1.80 | 125.0 | 2/ 2 | 250.0 |
| 13/ 17 | 2.0 | 800 | 10 | YES | 1.9 | 819.0 | 823.2 | 866.5 | 828.8 | 801.4 | 962.4 | 2.01 | 1.80 | 125.0 | 2/ 2 | 150.0 |
| 13/ 18 | 2.0 | 700 | 10 | NO | - | 714.7 | 724.0 | 764.5 | 723.0 | 700.9 | 845.9 | 2.06 | 1.80 | 125.0 | 1/ 5 | 50.0 |
| 13/ 19 | 2.0 | 700 | 10 | NO | - | 708.5 | 728.4 | 783.5 | 700.9 | 699.9 | 847.2 | 2.04 | 1.80 | 125.0 | 1/ 5 | 50.0 |
| 13/ 20 | 2.0 | 700 | 10 | NO | - | 712.7 | 725.8 | 796.0 | 697.7 | 699.9 | 848.7 | 2.00 | 1.80 | 125.0 | 1/ 5 | 50.0 |
| 13/ 21 | 4.0 | 1150 | 10 | YES | .8 | 1192.2 | 1187.7 | 1245.4 | 1201.7 | 1148.3 | 1417.5 | 4.01 | 1.80 | 125.0 | 1/ 1 | 275.0 |
| 13/ 22 | 4.0 | 1050 | 10 | YES | .7 | 1085.4 | 1088.8 | 1136.9 | 1099.7 | 1046.0 | 1292.3 | 4.01 | 1.80 | 125.0 | 1/ 1 | 175.0 |
| 13/ 23 | 4.0 | 950 | 10 | NO | - | 983.0 | 979.8 | 1027.3 | 993.7 | 945.9 | 1171.7 | 3.98 | 1.80 | 125.0 | 1/ 3 | 75.0 |
| 13/ 24 | 4.0 | 950 | 10 | NO | - | 975.7 | 983.4 | 1054.1 | 964.8 | 949.4 | 1182.3 | 4.02 | 1.80 | 125.0 | 1/ 3 | 75.0 |
| 13/ 25 | 4.0 | 950 | 10 | YES | 2.9 | 966.1 | 991.4 | 1065.2 | 953.4 | 948.5 | 1184.1 | 4.03 | 1.80 | 125.0 | 1/ 3 | 75.0 |
| 13/ 26 | 4.0 | 925 | 10 | NO | - | 953.7 | 951.0 | 1018.0 | 962.0 | 923.9 | 1141.0 | 3.86 | 1.80 | 125.0 | 1/ 3 | 50.0 |
| 13/ 27 | 4.0 | 925 | 10 | NO | - | 949.4 | 958.3 | 1028.8 | 964.5 | 928.2 | 1144.8 | 4.04 | 1.80 | 125.0 | 1/ 3 | 50.0 |
| 13/ 28 | 4.0 | 925 | 10 | YES | 2.5 | 958.2 | 955.8 | 1035.4 | 958.3 | 923.7 | 1144.2 | 3.99 | 1.80 | 125.0 | 1/ 3 | 50.0 |
| 13/ 29 | 4.0 | 900 | 10 | NO | - | 936.6 | 933.4 | 1001.5 | 944.0 | 903.1 | 1115.6 | 3.99 | 1.80 | 125.0 | 1/ 5 | 25.0 |
| 13/ 30 | 4.0 | 900 | 10 | NO | - | 925.3 | 939.7 | 999.7 | 942.8 | 905.1 | 1110.6 | 3.97 | 1.80 | 125.0 | 1/ 5 | 25.0 |
| 13/ 31 | 4.0 | 900 | 10 | YES | 2.9 | 935.3 | 937.0 | 1008.2 | 934.5 | 901.9 | 1115.8 | 4.03 | 1.80 | 125.0 | 1/ 5 | 25.0 |
| 13/ 32 | 4.0 | 875 | 10 | NO | - | 908.4 | 908.4 | 981.2 | 920.4 | 881.1 | 1089.9 | 3.89 | 1.80 | 125.0 | 0/ 4 | 0.0 |
| 13/ 33 | 4.0 | 875 | 10 | NO | - | 892.7 | 897.4 | 977.0 | 905.5 | 875.0 | 1077.7 | 4.11 | 1.80 | 125.0 | 0/ 4 | 0.0 |
| 13/ 34 | 4.0 | 875 | 10 | NO | - | 901.5 | 911.7 | 977.2 | 914.1 | 873.0 | 1076.2 | 3.97 | 1.80 | 125.0 | 0/ 4 | 0.0 |
| 13/ 35 | 4.0 | 875 | 10 | NO | - | 901.7 | 906.5 | 979.5 | 911.2 | 881.0 | 1079.8 | 4.06 | 1.80 | 125.0 | 0/ 4 | 0.0 |
| 13/ 36 | 6.0 | 1150 | 10 | YES | 1.1 | 1204.7 | 1197.7 | 1259.0 | 1217.8 | 1155.2 | 1445.5 | 6.08 | 1.80 | 125.0 | 4/ 4 | 125.0 |
| 13/ 37 | 6.0 | 1100 | 10 | NO | - | 1140.7 | 1136.3 | 1195.7 | 1165.4 | 1107.9 | 1387.0 | 6.01 | 1.80 | 125.0 | 2/ 6 | 75.0 |
| 13/ 38 | 6.0 | 1100 | 10 | YES | 5.9 | 1138.0 | 1138.2 | 1202.5 | 1151.8 | 1101.4 | 1377.9 | 6.13 | 1.80 | 125.0 | 2/ 6 | 75.0 |
| 13/ 39 | 5.5 | 1100 | 10 | NO | - | 1136.2 | 1145.8 | 1205.0 | 1148.1 | 1100.2 | 1396.6 | 5.34 | 1.80 | 125.0 | 0/ 1 | 1100.0 |
| 13/ 40 | 6.0 | 1075 | 10 | NO | - | 1118.8 | 1117.6 | 1165.2 | 1143.3 | 1079.7 | 1355.6 | 6.10 | 1.80 | 125.0 | 1/ 4 | 50.0 |

# TABLE V-4



F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

MIL-H-5606
DUCT & CLAMP
DRIP

| RUN/PT. | --- TEST -- CONDITIONS VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | THERMOCOUPLES T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | --- OVERALL --- LITES / ATTEMPT | M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13/ 41 | 6.0 | 1075 | 10 | NO | - | 1108.5 | 1120.3 | 1173.9 | 1125.4 | 1072.5 | 1348.7 | 6.09 | 1.80 | 125.0 | 1/ 4 | 50.0 |
| 13/ 42 | 6.0 | 1075 | 10 | NO | - | 1108.7 | 1116.3 | 1181.2 | 1122.9 | 1074.2 | 1346.1 | 6.06 | 1.80 | 125.0 | 1/ 4 | 50.0 |
| 13/ 43 | 8.0 | 1350 | 10 | YES | .5 | 1395.0 | 1401.4 | 1439.3 | 1432.0 | 1345.7 | 1702.4 | 8.08 | 1.80 | 125.0 | 1/ 1 | 200.0 |
| 13/ 44 | 8.0 | 1300 | 10 | YES | .7 | 1366.5 | 1363.5 | 1393.1 | 1389.2 | 1304.6 | 1656.5 | 7.95 | 1.80 | 125.0 | 1/ 1 | 150.0 |
| 13/ 45 | 8.0 | 1275 | 10 | YES | .8 | 1340.4 | 1326.8 | 1363.3 | 1364.8 | 1280.6 | 1625.2 | 7.89 | 1.80 | 125.0 | 1/ 1 | 125.0 |
| 13/ 46 | 8.0 | 1250 | 10 | YES | 5.8 | 1310.6 | 1301.2 | 1330.7 | 1335.2 | 1252.2 | 1586.4 | 8.03 | 1.80 | 125.0 | 2/ 2 | 100.0 |
| 13/ 47 | 8.0 | 1250 | 10 | YES | 1.9 | 1297.3 | 1311.4 | 1301.6 | 1321.8 | 1251.2 | 1594.4 | 7.95 | 1.80 | 125.0 | 2/ 2 | 100.0 |
| 13/ 48 | 8.0 | 1200 | 10 | YES | 6.7 | 1237.0 | 1245.6 | 1274.0 | 1267.0 | 1192.2 | 1515.1 | 7.97 | 1.80 | 125.0 | 1/ 1 | 50.0 |
| 13/ 49 | 8.0 | 1175 | 10 | YES | 7.8 | 1218.5 | 1222.9 | 1260.0 | 1239.1 | 1175.2 | 1495.4 | 8.18 | 1.80 | 125.0 | 1/ 1 | 25.0 |
| 13/ 50 | 8.0 | 1150 | 10 | NO | - | 1189.9 | 1190.0 | 1241.7 | 1212.0 | 1153.2 | 1457.6 | 8.04 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 13/ 51 | 8.0 | 1150 | 10 | NO | - | 1175.2 | 1179.6 | 1245.9 | 1191.9 | 1138.0 | 1456.8 | 8.16 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 13/ 52 | 8.0 | 1150 | 10 | NO | - | 1169.5 | 1180.7 | 1261.0 | 1194.1 | 1143.6 | 1458.0 | 7.96 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 13/ 53 | 1.0 | 1300 | 10 | YES | .4 | 1359.2 | 1341.7 | 1327.7 | 1359.3 | 1303.6 | 1560.9 | .97 | 1.80 | 125.0 | 1/ 1 | 600.0 |
| 13/ 54 | 1.0 | 1100 | 10 | YES | .7 | 1135.0 | 1126.5 | 1119.4 | 1144.4 | 1099.0 | 1304.9 | 1.00 | 1.80 | 125.0 | 1/ 1 | 400.0 |
| 13/ 55 | 1.0 | 900 | 10 | YES | 1.2 | 919.6 | 920.9 | 926.6 | 928.6 | 899.9 | 1065.1 | 1.04 | 1.80 | 125.0 | 1/ 1 | 200.0 |
| 13/ 56 | 1.0 | 800 | 10 | NO | - | 817.4 | 810.8 | 829.5 | 822.8 | 797.9 | 944.1 | 1.06 | 1.80 | 125.0 | 0/ 3 | 100.0 |
| 13/ 57 | 1.0 | 800 | 10 | NO | - | 821.2 | 826.2 | 848.1 | 824.3 | 804.4 | 946.0 | 1.07 | 1.80 | 125.0 | 0/ 3 | 100.0 |
| 13/ 58 | 1.0 | 800 | 10 | NO | - | 823.5 | 804.8 | 843.9 | 826.5 | 802.2 | 941.9 | 1.03 | 1.80 | 125.0 | 0/ 3 | 100.0 |
| 13/ 59 | 1.0 | 750 | 10 | NO | - | 769.9 | 767.0 | 793.5 | 770.5 | 749.5 | 884.5 | .97 | 1.80 | 125.0 | 1/ 3 | 50.0 |
| 13/ 60 | 1.0 | 750 | 10 | NO | - | 767.3 | 766.0 | 791.5 | 765.6 | 747.7 | 884.0 | .98 | 1.80 | 125.0 | 1/ 3 | 50.0 |
| 13/ 61 | 1.0 | 750 | 10 | YES | 2.7 | 765.9 | 764.2 | 798.4 | 768.5 | 747.5 | 883.7 | 1.05 | 1.80 | 125.0 | 1/ 3 | 50.0 |
| 13/ 62 | 1.0 | 700 | 10 | NO | - | 708.3 | 715.6 | 737.8 | 718.5 | 696.6 | 822.4 | 1.02 | 1.80 | 125.0 | 0/ 4 | 0.0 |
| 13/ 63 | 1.0 | 700 | 10 | NO | - | 716.1 | 718.7 | 754.5 | 717.0 | 700.3 | 828.6 | 1.00 | 1.80 | 125.0 | 0/ 4 | 0.0 |
| 13/ 64 | 1.0 | 700 | 10 | NO | - | 709.1 | 722.5 | 775.0 | 698.1 | 701.5 | 836.3 | .93 | 1.80 | 125.0 | 0/ 4 | 0.0 |
| 13/ 65 | 1.0 | 700 | 10 | NO | - | 713.3 | 709.2 | 758.9 | 716.9 | 697.1 | 828.5 | 1.00 | 1.80 | 125.0 | 0/ 4 | 0.0 |
| 13/ 66 | 0.0 | 1200 | 10 | YES | 1.0 | 1237.9 | 1176.8 | 1248.0 | 1223.0 | 1196.3 | 1400.3 | 0.00 | 1.80 | 125.0 | 1/ 1 | 200.0 |
| 13/ 67 | 0.0 | 1100 | 10 | YES | 1.6 | 1137.6 | 1078.2 | 1133.7 | 1118.0 | 1099.7 | 1274.9 | 0.00 | 1.80 | 125.0 | 1/ 1 | 100.0 |
| 13/ 68 | 0.0 | 1000 | 10 | NO | - | 1019.2 | 972.9 | 1026.5 | 1006.5 | 996.5 | 1151.9 | 0.00 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 13/ 69 | 0.0 | 1000 | 10 | NO | - | 1015.7 | 965.4 | 1034.6 | 1009.4 | 998.3 | 1150.2 | 0.00 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 13/ 70 | 0.0 | 1000 | 10 | NO | - | 1021.1 | 977.9 | 1051.5 | 1006.7 | 1002.9 | 1159.0 | 0.00 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 13/ 71 | 6.0 | 1150 | 10 | YES | 4.1 | 1190.8 | 1198.9 | 1237.8 | 1220.2 | 1151.8 | 1448.6 | 5.96 | 1.80 | 125.0 | 4/ 4 | 125.0 |
| 13/ 72 | 6.0 | 1150 | 10 | YES | 2.0 | 1190.2 | 1195.4 | 1236.8 | 1210.1 | 1149.6 | 1446.7 | 5.91 | 1.80 | 125.0 | 4/ 4 | 125.0 |
| 13/ 73 | 6.0 | 1150 | 10 | YES | 3.1 | 1194.5 | 1195.5 | 1238.7 | 1211.1 | 1148.7 | 1449.8 | 5.96 | 1.80 | 125.0 | 4/ 4 | 125.0 |
| 13/ 74 | 6.0 | 1100 | 10 | YES | 2.0 | 1145.9 | 1152.9 | 1185.2 | 1161.1 | 1096.0 | 1384.4 | 5.94 | 1.80 | 125.0 | 2/ 6 | 75.0 |
| 13/ 75 | 6.0 | 1075 | 10 | YES | 2.4 | 1114.9 | 1126.8 | 1161.7 | 1135.9 | 1075.9 | 1355.4 | 5.96 | 1.80 | 125.0 | 1/ 4 | 50.0 |
| 13/ 76 | 6.0 | 1050 | 10 | NO | - | 1083.5 | 1090.9 | 1133.3 | 1098.6 | 1045.1 | 1322.7 | 5.92 | 1.80 | 125.0 | 1/ 6 | 25.0 |
| 13/ 77 | 6.0 | 1050 | 10 | NO | - | 1090.9 | 1091.6 | 1152.5 | 1089.5 | 1045.4 | 1331.4 | 5.95 | 1.80 | 125.0 | 1/ 6 | 25.0 |
| 13/ 78 | 6.0 | 1050 | 10 | YES | 3.9 | 1072.0 | 1091.3 | 1164.7 | 1081.9 | 1043.6 | 1334.3 | 6.06 | 1.80 | 125.0 | 1/ 6 | 25.0 |
| 13/ 79 | 6.0 | 1025 | 10 | NO | - | 1065.4 | 1072.5 | 1121.2 | 1073.2 | 1027.2 | 1292.1 | 6.01 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 13/ 80 | 6.0 | 1025 | 10 | NO | - | 1056.5 | 1068.1 | 1126.9 | 1082.5 | 1019.1 | 1288.2 | 5.91 | 1.80 | 125.0 | 0/ 3 | 0.0 |

# TABLE IV-4

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

MIL-H-5606
DUCT & CLAMP
DRIP

| RUN/PT. | --- TEST -- CONDITIONS VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | THERMOCOUPLES T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | --- OVERALL --- LITES / ATTEMPT | M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13/ 81 | 6.0 | 1025 | 10 | NO | - | 1061.5 | 1072.7 | 1138.4 | 1078.7 | 1026.0 | 1295.6 | 5.95 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 13/ 82 | 6.0 | 1050 | 10 | NO | - | 1098.3 | 1096.1 | 1140.0 | 1114.7 | 1050.9 | 1323.6 | 6.02 | 2.89 | 160.0 | 1/ 6 | 25.0 |
| 13/ 83 | 6.0 | 1050 | 10 | NO | - | 1087.9 | 1097.4 | 1144.9 | 1106.6 | 1048.9 | 1320.3 | 6.05 | 2.89 | 160.0 | 1/ 6 | 25.0 |
| 13/ 84 | 6.0 | 1050 | 10 | NO | - | 1071.0 | 1091.8 | 1167.5 | 1075.1 | 1047.0 | 1335.1 | 5.99 | 2.09 | 160.0 | 1/ 6 | 25.0 |
| 13/ 85 | 6.0 | 1100 | 10 | NO | - | 1138.8 | 1144.4 | 1178.9 | 1162.3 | 1098.0 | 1386.2 | 5.98 | .30 | 80.0 | 2/ 6 | 75.0 |
| 13/ 86 | 6.0 | 1100 | 10 | NO | - | 1136.5 | 1136.2 | 1177.7 | 1157.6 | 1096.3 | 1380.1 | 6.15 | .30 | 80.0 | 2/ 6 | 75.0 |
| 13/ 87 | 6.0 | 1100 | 10 | NO | - | 1139.9 | 1142.1 | 1185.5 | 1161.4 | 1101.8 | 1389.7 | 6.13 | .30 | 80.0 | 2/ 6 | 75.0 |
| 13/ 88 | 4.0 | 1225 | 10 | NO | - | 1275.0 | 1276.7 | 1302.2 | 1285.7 | 1226.6 | 1520.5 | 4.01 | .30 | 80.0 | 0/ 1 | 350.0 |
| 13/ 89 | 4.0 | 900 | 10 | NO | - | 931.9 | 944.3 | 969.7 | 943.2 | 901.1 | 1109.0 | 3.94 | .30 | 80.0 | 1/ 5 | 25.0 |
| 13/ 90 | 4.0 | 900 | 10 | NO | - | 926.3 | 936.5 | 971.0 | 945.5 | 897.5 | 1112.7 | 3.94 | .30 | 80.0 | 1/ 5 | 25.0 |

# TABLE V-5

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

MIL-H-5606
OBSTRUCTIONS
DRIP

| RUN/PT. | --- TEST -- CONDITIONS VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | ------------- THERMOCOUPLES ------------- T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | --- OVERALL --- LITES / ATTEMPT | M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21/ 1 | 4.0 | 1300 | 10 | YES | .8 | 1322.3 | 1317.7 | 1292.4 | 1291.5 | 1297.3 | 1541.9 | 3.94 | 1.80 | 125.0 | 1/ 1 | 400.0 |
| 21/ 2 | 4.0 | 1200 | 10 | YES | 1.1 | 1218.1 | 1222.1 | 1185.9 | 1204.2 | 1196.4 | 1413.3 | 4.08 | 1.80 | 125.0 | 1/ 1 | 300.0 |
| 21/ 3 | 4.0 | 1100 | 10 | YES | 1.1 | 1115.1 | 1122.4 | 1091.0 | 1103.1 | 1093.9 | 1294.4 | 4.06 | 1.80 | 125.0 | 1/ 1 | 200.0 |
| 21/ 4 | 4.0 | 1000 | 10 | YES | 1.4 | 1011.5 | 1024.2 | 992.9 | 1000.4 | 996.8 | 1176.2 | 4.00 | 1.80 | 125.0 | 1/ 1 | 100.0 |
| 21/ 5 | 4.0 | 950 | 10 | YES | 2.3 | 958.3 | 975.1 | 944.2 | 949.3 | 944.4 | 1113.7 | 3.99 | 1.80 | 125.0 | 1/ 1 | 50.0 |
| 21/ 6 | 4.0 | 900 | 10 | NO | - | 911.1 | 925.0 | 898.9 | 901.4 | 899.0 | 1055.8 | 4.01 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 21/ 7 | 4.0 | 900 | 10 | NO | - | 908.4 | 922.7 | 905.3 | 897.4 | 898.3 | 1054.2 | 3.99 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 21/ 8 | 4.0 | 900 | 10 | NO | - | 904.5 | 917.6 | 913.6 | 901.6 | 895.6 | 1053.7 | 4.01 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 21/ 9 | 6.0 | 1200 | 10 | YES | 1.1 | 1213.6 | 1218.4 | 1187.1 | 1190.6 | 1196.9 | 1414.8 | 6.02 | 1.80 | 125.0 | 1/ 1 | 150.0 |
| 21/ 10 | 6.0 | 1100 | 10 | YES | 6.3 | 1110.3 | 1119.9 | 1084.2 | 1094.6 | 1097.3 | 1297.0 | 6.03 | 1.80 | 125.0 | 1/ 1 | 50.0 |
| 21/ 11 | 6.0 | 1050 | 10 | NO | - | 1056.0 | 1067.8 | 1032.4 | 1037.2 | 1047.0 | 1234.9 | 5.97 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 21/ 12 | 6.0 | 1050 | 10 | NO | - | 1057.1 | 1069.9 | 1049.0 | 1018.7 | 1047.6 | 1238.1 | 5.97 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 21/ 13 | 6.0 | 1050 | 10 | NO | - | 1059.2 | 1071.1 | 1039.0 | 1041.7 | 1046.9 | 1237.0 | 6.00 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 21/ 14 | 8.0 | 1300 | 10 | YES | .5 | 1317.5 | 1317.2 | 1275.2 | 1290.2 | 1296.5 | 1547.1 | 8.00 | 1.80 | 125.0 | 1/ 1 | 200.0 |
| 21/ 15 | 8.0 | 1250 | 10 | YES | 1.6 | 1270.3 | 1272.9 | 1226.4 | 1244.2 | 1250.4 | 1491.0 | 7.98 | 1.80 | 125.0 | 1/ 1 | 150.0 |
| 21/ 16 | 8.0 | 1200 | 10 | YES | 1.7 | 1213.6 | 1220.0 | 1171.5 | 1193.0 | 1199.6 | 1425.1 | 7.98 | 1.80 | 125.0 | 1/ 1 | 100.0 |
| 21/ 17 | 8.0 | 1150 | 10 | NO | - | 1158.9 | 1167.4 | 1119.6 | 1142.1 | 1147.4 | 1360.2 | 7.93 | 1.80 | 125.0 | 1/ 2 | 50.0 |
| 21/ 18 | 8.0 | 1150 | 10 | YES | 3.5 | 1158.2 | 1165.3 | 1125.6 | 1138.5 | 1145.0 | 1357.5 | 8.01 | 1.80 | 125.0 | 1/ 2 | 50.0 |
| 21/ 19 | 8.0 | 1100 | 10 | NO | - | 1106.5 | 1116.5 | 1076.4 | 1089.0 | 1097.3 | 1300.4 | 8.02 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 21/ 20 | 8.0 | 1100 | 10 | NO | - | 1106.3 | 1114.7 | 1079.2 | 1087.5 | 1095.5 | 1298.9 | 7.99 | 1.60 | 125.0 | 0/ 3 | 0.0 |
| 21/ 21 | 8.0 | 1100 | 10 | NO | - | 1104.9 | 1112.9 | 1076.8 | 1087.9 | 1094.2 | 1297.7 | 8.02 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 21/ 22 | 2.0 | 1300 | 10 | YES | .9 | 1336.1 | 1331.8 | 1307.0 | 1321.3 | 1297.1 | 1549.9 | 2.01 | 1.80 | 125.0 | 1/ 1 | 450.0 |
| 21/ 23 | 2.0 | 1000 | 10 | YES | 1.8 | 1028.5 | 1036.5 | 1011.0 | 1018.5 | 1002.7 | 1182.9 | 2.00 | 1.80 | 125.0 | 2/ 2 | 150.0 |
| 21/ 24 | 2.0 | 900 | 10 | YES | 2.5 | 923.8 | 934.0 | 911.5 | 916.6 | 900.9 | 1058.0 | 2.02 | 1.80 | 125.0 | 1/ 1 | 50.0 |
| 21/ 25 | 2.0 | 800 | 10 | NO | - | 816.8 | 828.4 | 811.7 | 813.0 | 801.6 | 932.9 | 2.05 | 1.80 | 125.0 | 0/ 1 | -50.0 |
| 21/ 26 | 2.0 | 1000 | 10 | YES | 1.3 | 1025.6 | 1030.9 | 1031.1 | 1015.2 | 1002.0 | 1179.6 | 2.00 | 1.80 | 125.0 | 2/ 2 | 150.0 |
| 21/ 27 | 2.0 | 850 | 10 | NO | - | 865.3 | 875.6 | 864.2 | 858.4 | 850.1 | 993.2 | 2.02 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 21/ 28 | 2.0 | 850 | 10 | NO | - | 865.6 | 874.8 | 875.8 | 858.9 | 850.0 | 993.4 | 2.01 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 21/ 29 | 2.0 | 850 | 10 | NO | - | 864.9 | 874.5 | 882.1 | 859.9 | 850.8 | 995.4 | 1.99 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 21/ 30 | 10.0 | 1300 | 10 | YES | .9 | 1317.3 | 1309.9 | 1269.6 | 1286.3 | 1299.8 | 1547.9 | 9.90 | 1.80 | 125.0 | 2/ 2 | 100.0 |
| 21/ 31 | 10.0 | 1200 | 10 | NO | - | 1211.0 | 1210.8 | 1162.9 | 1186.2 | 1200.6 | 1422.9 | 10.05 | 1.80 | 125.0 | 0/ 4 | 0.0 |
| 21/ 32 | 10.0 | 1300 | 10 | YES | .9 | 1319.4 | 1312.2 | 1268.7 | 1291.0 | 1301.2 | 1551.9 | 9.81 | 1.80 | 125.0 | 2/ 2 | 100.0 |
| 21/ 33 | 10.0 | 1250 | 10 | YES | 2.0 | 1270.1 | 1268.5 | 1222.0 | 1245.4 | 1254.3 | 1493.2 | 10.04 | 1.80 | 125.0 | 1/ 1 | 50.0 |
| 21/ 34 | 10.0 | 1200 | 10 | NO | - | 1211.6 | 1212.0 | 1166.7 | 1188.9 | 1199.9 | 1425.7 | 9.95 | 1.80 | 125.0 | 0/ 4 | 0.0 |
| 21/ 35 | 10.0 | 1200 | 10 | NO | - | 1209.4 | 1208.3 | 1169.3 | 1185.7 | 1197.8 | 1422.3 | 9.97 | 1.80 | 125.0 | 0/ 4 | 0.0 |
| 21/ 36 | 10.0 | 1200 | 10 | NO | - | 1211.1 | 1210.9 | 1170.6 | 1184.6 | 1198.9 | 1425.6 | 10.14 | 1.80 | 125.0 | 0/ 4 | 0.0 |
| 21/ 37 | 1.0 | 1100 | 10 | YES | 1.1 | 1129.2 | 1132.8 | 1121.3 | 1116.4 | 1098.1 | 1299.6 | 1.06 | 1.80 | 125.0 | 2/ 2 | 300.0 |
| 21/ 38 | 1.0 | 1000 | 10 | NO | - | 1026.0 | 1034.0 | 1023.3 | 1012.5 | 998.7 | 1176.4 | .99 | 1.80 | 125.0 | 1/ 2 | 200.0 |
| 21/ 39 | 1.0 | 1100 | 10 | YES | 1.1 | 1133.6 | 1138.3 | 1133.3 | 1119.3 | 1101.2 | 1300.2 | 1.01 | 1.80 | 125.0 | 2/ 2 | 300.0 |
| 21/ 40 | 1.0 | 1050 | 10 | YES | 1.2 | 1077.5 | 1086.3 | 1078.6 | 1064.5 | 1050.7 | 1238.3 | 1.02 | 1.80 | 125.0 | 1/ 1 | 250.0 |

# TABLE V-5



F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

MIL-H-5606
OBSTRUCTIONS
DRIP

| RUN/PT. | --- TEST -- CONDITIONS VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | THERMOCOUPLES T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | --- OVERALL --- LITES / ATTEMPT | M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21/ 41 | 1.0 | 1000 | 10 | YES | 1.6 | 1026.7 | 1037.3 | 1031.2 | 1013.9 | 1001.2 | 1177.4 | 1.04 | 1.80 | 125.0 | 1/ 2 | 200.0 |
| 21/ 42 | 1.0 | 950 | 10 | NO | - | 975.0 | 985.1 | 981.0 | 962.4 | 952.0 | 1119.4 | 1.03 | 1.80 | 125.0 | 1/ 2 | 150.0 |
| 21/ 43 | 1.0 | 950 | 10 | YES | 1.3 | 967.1 | 977.4 | 984.6 | 952.6 | 946.5 | 1111.3 | 1.00 | 1.80 | 125.0 | 1/ 2 | 150.0 |
| 21/ 44 | 1.0 | 900 | 10 | YES | 2.9 | 922.7 | 933.1 | 935.8 | 910.0 | 902.7 | 1053.0 | .99 | 1.80 | 125.0 | 1/ 1 | 100.0 |
| 21/ 45 | 1.0 | 850 | 10 | NO | - | 866.6 | 878.6 | 879.0 | 856.9 | 846.8 | 986.9 | 1.03 | 1.80 | 125.0 | 1/ 2 | 50.0 |
| 21/ 46 | 1.0 | 850 | 10 | YES | 1.3 | 870.5 | 881.4 | 891.6 | 860.0 | 849.5 | 994.5 | 1.04 | 1.80 | 125.0 | 1/ 2 | 50.0 |
| 21/ 47 | 1.0 | 800 | 10 | NO | - | 815.9 | 827.3 | 832.7 | 805.2 | 799.3 | 930.7 | .99 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 21/ 48 | 1.0 | 800 | 10 | NO | - | 816.1 | 826.6 | 840.2 | 807.0 | 801.3 | 932.8 | 1.01 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 21/ 49 | 1.0 | 800 | 10 | NO | - | 818.4 | 826.7 | 849.1 | 809.0 | 801.3 | 937.8 | 1.02 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 21/ 50 | 0.0 | 1100 | 10 | YES | 1.1 | 1127.8 | 1108.9 | 1145.9 | 1116.1 | 1104.1 | 1284.0 | .17 | 1.80 | 125.0 | 1/ 1 | 150.0 |
| 21/ 51 | 0.0 | 1050 | 10 | YES | 1.1 | 1070.4 | 1051.4 | 1084.8 | 1058.6 | 1048.2 | 1217.5 | .14 | 1.80 | 125.0 | 1/ 1 | 100.0 |
| 21/ 52 | 0.0 | 1000 | 10 | NO | - | 1019.4 | 1002.9 | 1034.4 | 1006.5 | 996.5 | 1163.1 | .10 | 1.80 | 125.0 | 1/ 2 | 50.0 |
| 21/ 53 | 0.0 | 1000 | 10 | YES | 1.0 | 1013.6 | 999.8 | 1040.5 | 997.4 | 996.0 | 1159.0 | 0.00 | 1.80 | 125.0 | 1/ 2 | 50.0 |
| 21/ 54 | 0.0 | 950 | 10 | NO | - | 970.8 | 956.9 | 988.4 | 960.4 | 952.3 | 1102.7 | .22 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 21/ 55 | 0.0 | 950 | 10 | NO | - | 970.0 | 957.2 | 998.2 | 959.8 | 954.9 | 1104.3 | 0.00 | 1.80 | 125.0 | 0/ 3 | 0.0 |
| 21/ 56 | 0.0 | 950 | 10 | NO | - | 967.6 | 951.7 | 993.4 | 959.7 | 948.6 | 1099.7 | 0.00 | 1.80 | 125.0 | 0/ 3 | 0.0 |

# TABLE V-6



F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

JP-4
BARE DUCT
SPRAY

| RUN/PT. | --- TEST -- CONDITIONS VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | THERMOCOUPLES T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | --- OVERALL --- LITES / ATTEMPT | M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/ 1 | 2.0 | 1400 | 5 | YES | .6 | 1412.6 | 1405.8 | 1445.5 | 1406.9 | 1400.2 | 1666.4 | 1.96 | 4.63 | 25.6 | 2/ 6 | 150.0 |
| 11/ 2 | 4.0 | 1400 | 5 | YES | 1.2 | 1407.5 | 1406.2 | 1451.1 | 1408.3 | 1395.6 | 1681.1 | 4.09 | 4.62 | 25.4 | 1/ 1 | 150.0 |
| 11/ 3 | 6.0 | 1400 | 5 | YES | .9 | 1420.8 | 1429.1 | 1458.7 | 1421.5 | 1397.7 | 1706.0 | 5.96 | 4.61 | 25.2 | 1/ 1 | 150.0 |
| 11/ 4 | 8.0 | 1375 | 5 | YES | 1.3 | 1388.3 | 1402.1 | 1438.9 | 1400.0 | 1382.0 | 1695.6 | 7.96 | 4.62 | 25.3 | 1/ 1 | 125.0 |
| 11/ 5 | 8.0 | 1350 | 5 | YES | 1.3 | 1359.1 | 1362.5 | 1407.0 | 1361.7 | 1344.8 | 1653.9 | 8.01 | 4.62 | 25.4 | 1/ 1 | 100.0 |
| 11/ 6 | 8.0 | 1325 | 5 | YES | 4.3 | 1336.8 | 1333.0 | 1383.4 | 1339.9 | 1319.7 | 1623.3 | 8.07 | 4.61 | 25.3 | 1/ 1 | 75.0 |
| 11/ 7 | 8.0 | 1300 | 5 | NO | - | 1311.5 | 1312.6 | 1363.3 | 1320.2 | 1301.7 | 1592.4 | 7.92 | 4.62 | 25.4 | 1/ 3 | 50.0 |
| 11/ 8 | 8.0 | 1300 | 5 | NO | - | 1309.2 | 1316.2 | 1361.8 | 1320.4 | 1298.8 | 1595.7 | 8.03 | 4.61 | 25.2 | 1/ 3 | 50.0 |
| 11/ 9 | 6.0 | 1300 | 5 | YES | 3.2 | 1305.9 | 1307.8 | 1359.1 | 1317.3 | 1298.9 | 1582.8 | 6.00 | 4.67 | 26.2 | 2/ 3 | 50.0 |
| 11/ 10 | 6.0 | 1275 | 5 | YES | 3.7 | 1277.8 | 1287.7 | 1332.1 | 1290.4 | 1273.3 | 1533.9 | 5.99 | 4.62 | 25.4 | 1/ 1 | 25.0 |
| 11/ 11 | 6.0 | 1250 | 5 | NO | - | 1259.2 | 1266.2 | 1312.1 | 1266.9 | 1248.4 | 1510.5 | 5.99 | 4.63 | 25.6 | 0/ 3 | 0.0 |
| 11/ 12 | 6.0 | 1250 | 5 | NO | - | 1255.3 | 1266.5 | 1312.8 | 1269.9 | 1244.7 | 1505.5 | 5.91 | 4.62 | 25.5 | 0/ 3 | 0.0 |
| 11/ 13 | 4.0 | 1250 | 5 | NO | - | 1262.1 | 1267.3 | 1309.1 | 1267.1 | 1250.7 | 1491.1 | 3.97 | 4.62 | 25.5 | 0/ 3 | 0.0 |
| 11/ 14 | 4.0 | 1250 | 5 | NO | - | 1259.1 | 1266.8 | 1307.8 | 1270.1 | 1246.4 | 1485.6 | 4.00 | 4.61 | 25.3 | 0/ 3 | 0.0 |
| 11/ 15 | 4.0 | 1275 | 5 | NO | - | 1285.4 | 1293.1 | 1336.8 | 1295.7 | 1275.0 | 1527.7 | 4.02 | 4.62 | 25.4 | 3/ 4 | 25.0 |
| 11/ 16 | 4.0 | 1275 | 5 | YES | .8 | 1299.3 | 1302.8 | 1347.7 | 1305.0 | 1285.9 | 1541.4 | 4.00 | 4.64 | 25.7 | 3/ 4 | 25.0 |
| 11/ 17 | 4.0 | 1275 | 5 | YES | 1.2 | 1293.8 | 1311.9 | 1343.9 | 1309.6 | 1283.7 | 1535.6 | 4.03 | 4.60 | 25.2 | 3/ 4 | 25.0 |
| 11/ 18 | 4.0 | 1275 | 5 | YES | 1.4 | 1280.3 | 1294.9 | 1332.5 | 1289.5 | 1272.6 | 1530.6 | 4.00 | 4.61 | 25.2 | 3/ 4 | 25.0 |
| 11/ 19 | 2.0 | 1275 | 5 | YES | 2.6 | 1278.7 | 1281.8 | 1322.4 | 1284.1 | 1273.1 | 1504.7 | 2.04 | 4.61 | 25.3 | 1/ 1 | 25.0 |
| 11/ 20 | 2.0 | 1250 | 5 | NO | - | 1262.1 | 1257.3 | 1294.1 | 1257.5 | 1251.7 | 1473.7 | 1.99 | 4.61 | 25.3 | 0/ 4 | 0.0 |
| 11/ 21 | 2.0 | 1250 | 5 | NO | - | 1262.0 | 1266.1 | 1302.2 | 1262.8 | 1253.1 | 1479.2 | 1.97 | 4.61 | 25.3 | 0/ 4 | 0.0 |
| 11/ 22 | 2.0 | 1250 | 5 | NO | - | 1262.9 | 1263.1 | 1297.5 | 1258.3 | 1248.3 | 1477.4 | 1.97 | 4.61 | 25.3 | 0/ 4 | 0.0 |
| 11/ 23 | 1.0 | 1275 | 0 | NO | - | 1294.1 | 1284.9 | 1314.1 | 1284.4 | 1279.7 | 1493.7 | 1.07 | 4.62 | 25.3 | 0/ 0 | 1275.0 |
| 11/ 24 | 1.0 | 1275 | 0 | NO | - | 1292.3 | 1288.6 | 1318.1 | 1285.7 | 1278.5 | 1496.1 | 1.05 | 4.62 | 25.4 | 0/ 0 | 1275.0 |
| 11/ 25 | 1.0 | 1300 | 0 | YES | 1.2 | 1312.3 | 1306.9 | 1335.5 | 1301.3 | 1298.3 | 1520.1 | 1.03 | 4.60 | 25.1 | 0/ 2 | 1300.0 |
| 11/ 26 | 1.0 | 1275 | 0 | YES | 7.6 | 1291.4 | 1282.2 | 1307.2 | 1277.6 | 1276.7 | 1478.5 | 1.01 | 4.59 | 25.0 | 0/ 0 | 1275.0 |
| 11/ 27 | 1.0 | 1275 | 0 | NO | - | 1293.1 | 1289.3 | 1308.7 | 1280.5 | 1279.2 | 1480.4 | 1.02 | 4.60 | 25.1 | 0/ 0 | 1275.0 |
| 11/ 28 | 0.0 | 1300 | 5 | YES | 7.8 | 1307.3 | 1273.4 | 1333.5 | 1264.7 | 1297.1 | 1485.0 | 0.00 | 4.64 | 25.8 | 2/ 4 | 25.0 |
| 11/ 29 | 0.0 | 1300 | 5 | NO | - | 1315.9 | 1276.8 | 1340.0 | 1265.9 | 1300.9 | 1480.2 | 0.00 | 4.60 | 25.1 | 2/ 4 | 25.0 |
| 11/ 30 | 0.0 | 1300 | 5 | NO | - | 1312.8 | 1272.8 | 1333.1 | 1260.3 | 1292.4 | 1479.3 | 0.00 | 4.59 | 24.9 | 2/ 4 | 25.0 |
| 11/ 31 | 0.0 | 1300 | 5 | YES | 9.3 | 1317.1 | 1273.3 | 1337.1 | 1268.6 | 1298.3 | 1488.4 | 0.00 | 4.59 | 24.9 | 2/ 4 | 25.0 |
| 11/ 32 | 0.0 | 1275 | 5 | NO | - | 1282.2 | 1246.7 | 1307.8 | 1234.5 | 1275.4 | 1434.2 | 0.00 | 4.56 | 24.5 | 0/ 2 | 0.0 |
| 11/ 33 | 0.0 | 1275 | 5 | NO | - | 1274.0 | 1243.0 | 1309.4 | 1236.2 | 1276.2 | 1433.3 | 0.00 | 4.59 | 24.9 | 0/ 2 | 0.0 |
| 11/ 34 | 1.0 | 1300 | 5 | NO | - | 1305.1 | 1289.1 | 1326.3 | 1290.4 | 1292.6 | 1496.1 | .95 | 14.19 | 297.5 | 0/ 2 | 1300.0 |
| 11/ 35 | 2.0 | 1300 | 5 | YES | 1.6 | 1305.7 | 1311.0 | 1340.3 | 1305.7 | 1295.8 | 1497.4 | 1.92 | 14.26 | 300.4 | 1/15 | 50.0 |
| 11/ 36 | 4.0 | 1300 | 5 | YES | 1.2 | 1315.4 | 1322.0 | 1353.8 | 1310.9 | 1301.0 | 1531.5 | 4.11 | 14.28 | 301.1 | 1/ 1 | 50.0 |
| 11/ 37 | 6.0 | 1300 | 5 | NO | - | 1311.2 | 1318.6 | 1357.7 | 1314.2 | 1296.1 | 1558.0 | 6.00 | 14.28 | 301.3 | 2/ 3 | 50.0 |
| 11/ 38 | 6.0 | 1300 | 5 | YES | .9 | 1307.2 | 1319.1 | 1365.1 | 1320.3 | 1299.5 | 1571.3 | 6.01 | 14.27 | 301.0 | 2/ 3 | 50.0 |
| 11/ 39 | 8.0 | 1300 | 5 | YES | 2.2 | 1315.6 | 1317.7 | 1365.0 | 1318.6 | 1296.3 | 1578.0 | 7.91 | 14.28 | 301.1 | 1/ 3 | 50.0 |
| 11/ 40 | 8.0 | 1275 | 5 | NO | - | 1291.6 | 1294.9 | 1343.3 | 1294.1 | 1281.5 | 1558.9 | 7.88 | 14.27 | 300.8 | 1/ 2 | 25.0 |

# TABLE V-6

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

JP-4
BARE DUCT
SPRAY

| RUN/PT. | --- TEST -- CONDITIONS VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | THERMOCOUPLES T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | --- OVERALL --- LITES / ATTEMPT | M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/ 41 | 8.0 | 1275 | 5 | YES | 1.9 | 1287.0 | 1297.2 | 1343.4 | 1297.5 | 1274.5 | 1554.8 | 7.80 | 14.25 | 299.9 | 1/ 2 | 25.0 |
| 11/ 42 | 8.0 | 1250 | 5 | NO | - | 1261.1 | 1258.6 | 1315.6 | 1269.1 | 1251.3 | 1523.8 | 7.81 | 14.25 | 299.9 | 0/ 3 | 0.0 |
| 11/ 43 | 8.0 | 1250 | 5 | NO | - | 1264.7 | 1267.5 | 1325.0 | 1278.2 | 1255.0 | 1528.8 | 7.92 | 14.23 | 299.1 | 0/ 3 | 0.0 |
| 11/ 44 | 8.0 | 1250 | 5 | NO | - | 1253.8 | 1265.4 | 1318.2 | 1271.8 | 1245.8 | 1519.3 | 8.03 | 14.21 | 298.4 | 0/ 3 | 0.0 |
| 11/ 45 | 6.0 | 1250 | 5 | NO | - | 1263.8 | 1270.0 | 1318.9 | 1275.7 | 1253.1 | 1515.5 | 5.97 | 14.20 | 298.0 | 0/ 3 | 0.0 |
| 11/ 46 | 4.0 | 1250 | 5 | NO | - | 1255.5 | 1269.7 | 1314.2 | 1270.7 | 1259.0 | 1501.3 | 4.09 | 14.20 | 297.8 | 0/ 3 | 0.0 |
| 11/ 47 | 2.0 | 1250 | 5 | NO | - | 1262.0 | 1265.5 | 1302.3 | 1266.4 | 1255.3 | 1468.2 | 2.00 | 14.20 | 297.9 | 0/ 4 | 0.0 |
| 11/ 48 | 2.0 | 1300 | 5 | NO | - | 1327.9 | 1303.7 | 1342.3 | 1307.3 | 1298.2 | 1532.7 | 2.00 | 3.29 | 30.2 | 1/15 | 50.0 |
| 11/ 49 | 2.0 | 1300 | 5 | NO | - | 1320.4 | 1313.7 | 1338.5 | 1305.2 | 1302.7 | 1532.6 | 2.01 | 3.33 | 30.9 | 1/15 | 50.0 |
| 11/ 50 | 2.0 | 1300 | 5 | NO | - | 1333.8 | 1310.0 | 1343.8 | 1307.3 | 1309.4 | 1544.0 | 2.06 | 4.52 | 51.4 | 1/15 | 50.0 |
| 11/ 51 | 2.0 | 1300 | 5 | NO | - | 1315.4 | 1307.4 | 1331.1 | 1297.1 | 1297.7 | 1527.6 | 2.03 | 4.58 | 52.5 | 1/15 | 50.0 |
| 11/ 52 | 2.0 | 1300 | 5 | NO | - | 1322.6 | 1305.3 | 1335.5 | 1300.9 | 1301.8 | 1529.4 | 2.04 | 7.42 | 115.1 | 1/15 | 50.0 |
| 11/ 53 | 2.0 | 1300 | 5 | NO | - | 1321.6 | 1304.9 | 1336.6 | 1301.4 | 1299.4 | 1531.1 | 2.02 | 7.39 | 114.3 | 1/15 | 50.0 |
| 11/ 54 | 2.0 | 1300 | 5 | NO | - | 1318.5 | 1297.5 | 1328.9 | 1298.7 | 1299.1 | 1513.1 | 2.06 | 8.89 | 157.8 | 1/15 | 50.0 |
| 11/ 55 | 2.0 | 1300 | 5 | NO | - | 1320.8 | 1296.5 | 1334.9 | 1302.7 | 1303.3 | 1530.4 | 2.05 | 8.95 | 159.8 | 1/15 | 50.0 |
| 11/ 56 | 2.0 | 1300 | 5 | NO | - | 1317.6 | 1299.8 | 1333.2 | 1299.0 | 1300.0 | 1524.8 | 2.02 | 10.46 | 212.5 | 1/15 | 50.0 |
| 11/ 57 | 2.0 | 1300 | 5 | NO | - | 1319.9 | 1303.6 | 1331.7 | 1296.6 | 1300.8 | 1526.0 | 2.04 | 10.46 | 212.5 | 1/15 | 50.0 |
| 11/ 58 | 2.0 | 1300 | 5 | NO | - | 1324.5 | 1304.2 | 1335.3 | 1301.7 | 1303.5 | 1529.7 | 2.03 | 12.31 | 287.0 | 1/15 | 50.0 |
| 11/ 59 | 2.0 | 1400 | 5 | NO | - | 1419.0 | 1406.9 | 1434.3 | 1406.1 | 1399.6 | 1658.4 | 2.01 | 12.35 | 288.7 | 2/ 6 | 150.0 |
| 11/ 60 | 2.0 | 1400 | 5 | NO | - | 1427.2 | 1406.6 | 1433.4 | 1407.3 | 1400.6 | 1656.9 | 2.02 | 12.34 | 288.2 | 2/ 6 | 150.0 |
| 11/ 61 | 2.0 | 1400 | 5 | NO | - | 1421.4 | 1413.5 | 1431.5 | 1405.4 | 1407.3 | 1659.3 | 2.02 | 14.80 | 404.9 | 2/ 6 | 150.0 |
| 11/ 62 | 2.0 | 1400 | 5 | NO | - | 1426.7 | 1413.0 | 1433.9 | 1404.4 | 1400.7 | 1656.5 | 1.97 | 14.80 | 405.1 | 2/ 6 | 150.0 |
| 11/ 63 | 2.0 | 1400 | 5 | YES | 5.0 | 1420.6 | 1405.4 | 1435.9 | 1404.3 | 1398.3 | 1663.3 | 1.98 | 14.32 | 379.1 | 2/ 6 | 150.0 |
| 11/ 64 | 2.0 | 1300 | 5 | NO | - | 1316.8 | 1306.8 | 1329.4 | 1300.2 | 1299.5 | 1528.7 | 2.03 | 14.26 | 376.0 | 1/15 | 50.0 |
| 11/ 65 | 2.0 | 1300 | 5 | NO | - | 1311.8 | 1302.9 | 1335.6 | 1303.1 | 1300.2 | 1531.9 | 2.07 | 14.23 | 374.4 | 1/15 | 50.0 |
| 11/ 66 | 2.0 | 1300 | 5 | NO | - | 1320.9 | 1300.0 | 1328.9 | 1297.2 | 1290.6 | 1525.8 | 2.03 | 13.85 | 355.5 | 1/15 | 50.0 |
| 11/ 67 | 1.0 | 1300 | 5 | NO | - | 1328.4 | 1307.9 | 1326.6 | 1300.4 | 1300.8 | 1517.8 | 1.07 | 13.81 | 354.0 | 0/ 2 | 1300.0 |

TABLE V-7



F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

JP-4
DUCT & CLAMP
SPRAY

| RUN/PT. | --- TEST -- CONDITIONS VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | ------ THERMOCOUPLES ------ T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | --- OVERALL --- LITES / ATTEMPT | M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17/ 1 | 2.0 | 1300 | 5 | YES | 6.4 | 1353.1 | 1348.0 | 1353.8 | 1355.0 | 1305.0 | 1618.5 | 2.00 | 8.40 | 98.7 | 4/ 4 | 75.0 |
| 17/ 2 | 2.0 | 1250 | 5 | NO | - | 1299.9 | 1296.6 | 1300.1 | 1307.0 | 1253.0 | 1547.3 | 1.98 | 8.38 | 98.1 | 1/ 9 | 25.0 |
| 17/ 3 | 2.0 | 1250 | 5 | NO | - | 1302.0 | 1297.3 | 1308.7 | 1309.3 | 1254.0 | 1551.3 | 1.99 | 8.36 | 97.6 | 1/ 9 | 25.0 |
| 17/ 4 | 2.0 | 1250 | 5 | NO | - | 1302.0 | 1297.8 | 1312.0 | 1306.3 | 1253.0 | 1553.9 | 2.00 | 8.34 | 97.2 | 1/ 9 | 25.0 |
| 17/ 5 | 2.0 | 1300 | 5 | YES | 5.9 | 1350.0 | 1345.5 | 1339.4 | 1359.9 | 1297.0 | 1614.8 | 2.00 | 14.39 | 306.0 | 4/ 4 | 75.0 |
| 17/ 6 | 2.0 | 1250 | 5 | YES | 6.1 | 1303.3 | 1299.9 | 1307.7 | 1304.9 | 1255.0 | 1553.3 | 2.01 | 14.27 | 301.0 | 1/ 9 | 25.0 |
| 17/ 7 | 2.0 | 1200 | 5 | NO | - | 1248.7 | 1248.2 | 1259.6 | 1256.9 | 1205.0 | 1492.9 | 1.98 | 14.15 | 295.5 | 0/ 3 | -25.0 |
| 17/ 8 | 2.0 | 1200 | 5 | NO | - | 1251.4 | 1248.3 | 1267.2 | 1251.5 | 1206.0 | 1496.3 | 1.98 | 14.08 | 292.6 | 0/ 3 | -25.0 |
| 17/ 9 | 2.0 | 1200 | 5 | NO | - | 1253.1 | 1250.4 | 1271.8 | 1253.4 | 1207.0 | 1498.1 | 2.03 | 14.02 | 290.3 | 0/ 3 | -25.0 |
| 17/ 10 | 4.0 | 1300 | 5 | NO | - | 1350.5 | 1346.6 | 1376.1 | 1356.0 | 1301.0 | 1632.0 | 3.92 | 13.91 | 285.3 | 0/ 5 | -25.0 |
| 17/ 11 | 4.0 | 1350 | 5 | NO | - | 1403.2 | 1398.6 | 1425.9 | 1410.2 | 1353.0 | 1695.2 | 3.96 | 13.85 | 282.8 | 2/ 3 | 25.0 |
| 17/ 12 | 4.0 | 1300 | 5 | NO | - | 1348.9 | 1345.8 | 1369.5 | 1371.9 | 1301.0 | 1633.7 | 4.06 | 4.48 | 23.2 | 0/ 5 | -25.0 |
| 17/ 13 | 4.0 | 1300 | 10 | NO | - | 1352.2 | 1348.9 | 1372.7 | 1366.5 | 1305.0 | 1635.4 | 4.01 | 4.51 | 23.7 | 0/ 5 | -25.0 |
| 17/ 14 | 2.0 | 1300 | 5 | YES | 6.0 | 1350.6 | 1345.7 | 1342.7 | 1367.4 | 1300.0 | 1605.9 | 2.02 | 4.44 | 22.6 | 4/ 4 | 75.0 |
| 17/ 15 | 4.0 | 1300 | 5 | NO | - | 1351.9 | 1348.3 | 1363.9 | 1369.9 | 1301.0 | 1632.1 | 4.00 | 4.41 | 22.1 | 0/ 5 | -25.0 |
| 17/ 16 | 4.0 | 1300 | 10 | NO | - | 1360.4 | 1355.8 | 1352.6 | 1377.4 | 1311.0 | 1643.5 | 4.06 | 4.41 | 22.1 | 0/ 5 | -25.0 |
| 17/ 18 | 2.0 | 1350 | 10 | YES | .6 | 1398.2 | 1394.5 | 1376.1 | 1423.0 | 1348.0 | 1660.9 | 2.05 | 4.65 | 25.8 | 2/ 2 | 125.0 |
| 17/ 19 | 2.0 | 1350 | 10 | YES | .9 | 1373.9 | 1372.0 | 1354.3 | 1390.1 | 1345.0 | 1632.7 | 1.99 | 4.58 | 24.8 | 2/ 2 | 125.0 |
| 17/ 20 | 2.0 | 1300 | 10 | YES | 11.1 | 1350.3 | 1348.2 | 1341.5 | 1370.4 | 1301.0 | 1604.6 | 2.05 | 4.50 | 23.6 | 4/ 4 | 75.0 |
| 17/ 21 | 2.0 | 1275 | 10 | YES | .5 | 1326.4 | 1323.2 | 1317.5 | 1344.8 | 1278.0 | 1575.4 | 1.97 | 4.43 | 22.5 | 1/ 1 | 50.0 |
| 17/ 22 | 2.0 | 1250 | 10 | NO | - | 1297.3 | 1296.3 | 1298.2 | 1317.9 | 1251.0 | 1535.4 | 2.03 | 4.36 | 21.3 | 1/ 9 | 25.0 |
| 17/ 23 | 2.0 | 1250 | 10 | NO | - | 1299.2 | 1297.4 | 1302.7 | 1322.0 | 1254.0 | 1542.1 | 2.01 | 4.58 | 24.8 | 1/ 9 | 25.0 |
| 17/ 24 | 2.0 | 1250 | 10 | NO | - | 1300.1 | 1297.9 | 1302.9 | 1321.0 | 1253.0 | 1544.2 | 2.03 | 4.73 | 27.2 | 1/ 9 | 25.0 |
| 17/ 25 | 2.0 | 1250 | 10 | NO | - | 1299.6 | 1297.9 | 1299.3 | 1320.4 | 1252.0 | 1541.8 | 2.03 | 13.96 | 287.7 | 1/ 9 | 25.0 |
| 17/ 26 | 2.0 | 1250 | 5 | NO | - | 1299.5 | 1297.9 | 1303.0 | 1322.0 | 1253.0 | 1539.6 | 2.04 | 13.41 | 264.4 | 1/ 9 | 25.0 |
| 17/ 27 | 4.0 | 1350 | 5 | YES | 5.7 | 1400.1 | 1395.5 | 1382.3 | 1416.7 | 1349.0 | 1681.4 | 4.07 | 4.84 | 28.9 | 2/ 3 | 25.0 |
| 17/ 28 | 4.0 | 1325 | 5 | NO | - | 1376.6 | 1372.0 | 1391.7 | 1390.7 | 1324.0 | 1650.9 | 4.07 | 4.88 | 29.5 | 0/ 7 | 0.0 |
| 17/ 29 | 4.0 | 1325 | 5 | NO | - | 1375.1 | 1370.2 | 1386.8 | 1388.0 | 1324.0 | 1650.5 | 4.00 | 4.87 | 29.3 | 0/ 7 | 0.0 |
| 17/ 30 | 4.0 | 1325 | 5 | NO | - | 1375.2 | 1370.2 | 1393.9 | 1393.8 | 1326.0 | 1651.8 | 4.03 | 4.86 | 29.2 | 0/ 7 | 0.0 |
| 17/ 31 | 4.0 | 1325 | 5 | NO | - | 1373.9 | 1369.9 | 1383.3 | 1389.6 | 1323.0 | 1650.7 | 4.02 | 9.92 | 139.2 | 0/ 7 | 0.0 |
| 17/ 32 | 4.0 | 1325 | 5 | NO | - | 1373.0 | 1368.2 | 1388.3 | 1389.0 | 1321.0 | 1649.4 | 4.00 | 9.88 | 138.2 | 0/ 7 | 0.0 |
| 17/ 33 | 4.0 | 1325 | 5 | NO | - | 1374.0 | 1369.8 | 1389.9 | 1395.1 | 1324.0 | 1648.6 | 4.03 | 9.86 | 137.6 | 0/ 7 | 0.0 |
| 17/ 34 | 4.0 | 1350 | 5 | YES | 6.1 | 1402.6 | 1397.7 | 1422.5 | 1420.3 | 1354.0 | 1681.3 | 4.03 | 9.84 | 137.1 | 2/ 3 | 25.0 |
| 17/ 35 | 4.0 | 1325 | 5 | NO | - | 1372.5 | 1367.8 | 1387.6 | 1390.5 | 1321.0 | 1647.8 | 3.97 | 9.79 | 135.5 | 0/ 7 | 0.0 |
| 17/ 36 | 6.0 | 1350 | 5 | NO | - | 1398.4 | 1393.5 | 1414.2 | 1420.3 | 1346.0 | 1694.4 | 6.00 | 9.73 | 133.8 | 0/ 3 | 1350.0 |
| 17/ 37 | 6.0 | 1350 | 5 | NO | - | 1398.0 | 1393.6 | 1417.6 | 1416.0 | 1344.0 | 1695.8 | 5.97 | 9.71 | 133.3 | 0/ 3 | 1350.0 |
| 17/ 38 | 6.0 | 1350 | 5 | NO | - | 1397.9 | 1392.9 | 1414.5 | 1415.8 | 1347.0 | 1693.4 | 5.96 | 9.70 | 132.8 | 0/ 3 | 1350.0 |
| 17/ 39 | 6.0 | 1375 | 5 | NO | - | 1431.6 | 1425.5 | 1446.8 | 1446.8 | 1379.0 | 1733.8 | 6.02 | 9.67 | 132.0 | 0/ 2 | 1375.0 |
| 17/ 40 | 6.0 | 1375 | 5 | NO | - | 1427.6 | 1422.3 | 1442.1 | 1446.0 | 1377.0 | 1729.5 | 5.95 | 4.51 | 23.7 | 0/ 2 | 1375.0 |
| 17/ 41 | 0.0 | 1375 | 5 | YES | .5 | 1397.0 | 1391.1 | 1379.3 | 1406.6 | 1376.0 | 1636.5 | 0.00 | 4.50 | 23.5 | 1/ 1 | 125.0 |

# TABLE V-7

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

JP-4
DUCT & CLAMP
SPRAY

| RUN/PT. | TEST CONDITIONS VEL | TEST CONDITIONS TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | THERMOCOUPLES T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | OVERALL LITES / ATTEMPT | OVERALL M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17/ 42 | 0.0 | 1325 | 5 | YES | 7.2 | 1352.3 | 1344.2 | 1349.5 | 1367.0 | 1328.0 | 1586.0 | 0.00 | 4.49 | 23.4 | 1/ 1 | 75.0 |
| 17/ 43 | 0.0 | 1300 | 5 | YES | 6.7 | 1325.5 | 1316.7 | 1325.7 | 1341.3 | 1302.0 | 1546.1 | 0.00 | 4.48 | 23.2 | 1/ 1 | 50.0 |
| 17/ 44 | 0.0 | 1275 | 5 | YES | 99.9 | 1298.1 | 1290.5 | 1303.6 | 1316.3 | 1275.0 | 1518.6 | 0.00 | 4.48 | 23.3 | 2/ 3 | 25.0 |
| 17/ 45 | 0.0 | 1275 | 5 | NO | - | 1297.5 | 1291.0 | 1308.6 | 1285.4 | 1275.0 | 1521.1 | 0.00 | 4.45 | 22.8 | 2/ 3 | 25.0 |
| 17/ 46 | 0.0 | 1275 | 5 | YES | 9.2 | 1304.2 | 1296.7 | 1318.7 | 1316.2 | 1284.0 | 1522.4 | .10 | 4.45 | 22.8 | 2/ 3 | 25.0 |
| 17/ 47 | 0.0 | 1250 | 5 | NO | - | 1274.7 | 1267.1 | 1290.9 | 1287.4 | 1254.0 | 1490.2 | .14 | 4.42 | 22.3 | 0/ 3 | 0.0 |
| 17/ 48 | 0.0 | 1250 | 5 | NO | - | 1273.8 | 1267.0 | 1287.8 | 1285.2 | 1253.0 | 1486.6 | .14 | 4.41 | 22.1 | 0/ 3 | 0.0 |
| 17/ 49 | 0.0 | 1250 | 5 | NO | - | 1275.0 | 1267.5 | 1295.6 | 1287.1 | 1253.0 | 1489.2 | .14 | 4.41 | 22.2 | 0/ 3 | 0.0 |
| 17/ 50 | 2.0 | 1225 | 5 | NO | - | 1273.1 | 1267.8 | 1282.8 | 1283.1 | 1224.0 | 1512.4 | 2.10 | 4.57 | 24.6 | 0/ 3 | 0.0 |
| 17/ 51 | 2.0 | 1225 | 5 | NO | - | 1272.8 | 1267.3 | 1285.9 | 1285.9 | 1226.0 | 1511.2 | 2.05 | 4.56 | 24.5 | 0/ 3 | 0.0 |
| 17/ 52 | 2.0 | 1225 | 5 | NO | - | 1277.2 | 1272.2 | 1293.0 | 1287.9 | 1230.0 | 1521.0 | 1.95 | 4.56 | 24.5 | 0/ 3 | 0.0 |

# TABLE V-B

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

JP-4
BARE DUCT
DRIP

| RUN/PT. | --- TEST -- CONDITIONS VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | ------------- THERMOCOUPLES ------------- T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | --- OVERALL --- LITES / ATTEMPT | M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/ 1 | 2.0 | 1300 | 10 | YES | 4.0 | 1312.3 | 1298.7 | 1326.7 | 1297.3 | 1300.7 | 1525.2 | 1.97 | .29 | 65.0 | 3/ 3 | 125.0 |
| 12/ 2 | 2.0 | 1300 | 10 | YES | 6.2 | 1310.5 | 1298.5 | 1327.7 | 1296.1 | 1298.5 | 1521.5 | 2.01 | .29 | 65.0 | 3/ 3 | 125.0 |
| 12/ 3 | 2.0 | 1250 | 10 | YES | 10.8 | 1263.6 | 1247.0 | 1274.7 | 1246.8 | 1248.4 | 1458.2 | 2.00 | .29 | 65.0 | 1/ 3 | 75.0 |
| 12/ 4 | 2.0 | 1200 | 10 | NO | - | 1210.6 | 1201.1 | 1233.8 | 1199.2 | 1199.9 | 1391.7 | 2.02 | .29 | 65.0 | 1/ 4 | 25.0 |
| 12/ 5 | 2.0 | 1200 | 10 | NO | - | 1217.8 | 1199.7 | 1234.8 | 1200.4 | 1201.1 | 1400.7 | 2.02 | .29 | 65.0 | 1/ 4 | 25.0 |
| 12/ 6 | 2.0 | 1200 | 10 | NO | - | 1218.3 | 1198.0 | 1236.0 | 1204.6 | 1202.5 | 1399.7 | 2.08 | .29 | 65.0 | 1/ 4 | 25.0 |
| 12/ 7 | 4.0 | 1300 | 10 | NO | - | 1317.8 | 1309.4 | 1315.8 | 1313.6 | 1300.3 | 1552.0 | 4.01 | .29 | 65.0 | 1/ 5 | 50.0 |
| 12/ 8 | 4.0 | 1400 | 10 | YES | 2.5 | 1419.7 | 1410.1 | 1444.6 | 1415.8 | 1399.1 | 1672.9 | 3.97 | .29 | 65.0 | 1/ 1 | 150.0 |
| 12/ 9 | 4.0 | 1350 | 10 | YES | 10.5 | 1369.8 | 1365.5 | 1397.1 | 1359.5 | 1353.0 | 1614.3 | 4.02 | .29 | 65.0 | 3/ 3 | 100.0 |
| 12/ 10 | 4.0 | 1325 | 10 | NO | - | 1346.0 | 1342.0 | 1370.4 | 1333.6 | 1327.1 | 1583.6 | 3.98 | .29 | 65.0 | 2/ 7 | 75.0 |
| 12/ 11 | 4.0 | 1325 | 0 | NO | - | 1343.6 | 1340.2 | 1369.9 | 1331.9 | 1326.7 | 1582.0 | 3.99 | .29 | 65.0 | 2/ 7 | 75.0 |
| 12/ 12 | 4.0 | 1325 | 10 | NO | - | 1342.3 | 1332.8 | 1368.9 | 1335.7 | 1324.2 | 1579.2 | 3.99 | .29 | 65.0 | 2/ 7 | 75.0 |
| 12/ 13 | 4.0 | 1325 | 10 | NO | - | 1343.1 | 1331.9 | 1368.3 | 1330.6 | 1324.3 | 1582.3 | 4.00 | .29 | 65.0 | 2/ 7 | 75.0 |
| 12/ 14 | 4.0 | 1325 | 10 | NO | - | 1343.9 | 1335.1 | 1370.5 | 1336.2 | 1326.1 | 1585.4 | 4.03 | .29 | 65.0 | 2/ 7 | 75.0 |
| 12/ 15 | 6.0 | 1400 | 10 | NO | - | 1420.5 | 1418.3 | 1454.2 | 1415.7 | 1402.9 | 1703.1 | 5.95 | .29 | 65.0 | 1/ 3 | 150.0 |
| 12/ 16 | 6.0 | 1400 | 10 | NO | - | 1421.6 | 1416.9 | 1452.1 | 1411.2 | 1399.9 | 1695.4 | 5.95 | .29 | 65.0 | 1/ 3 | 150.0 |
| 12/ 17 | 6.0 | 1400 | 10 | YES | 6.2 | 1422.2 | 1415.9 | 1452.0 | 1413.6 | 1399.3 | 1699.3 | 5.95 | .29 | 65.0 | 1/ 3 | 150.0 |
| 12/ 18 | 6.0 | 1375 | 10 | NO | - | 1397.8 | 1386.6 | 1426.4 | 1386.1 | 1374.8 | 1664.2 | 6.09 | .29 | 65.0 | 1/ 5 | 125.0 |
| 12/ 19 | 6.0 | 1375 | 10 | NO | - | 1390.6 | 1389.3 | 1425.5 | 1388.9 | 1377.2 | 1661.4 | 6.06 | .29 | 65.0 | 1/ 5 | 125.0 |
| 12/ 20 | 6.0 | 1375 | 10 | NO | - | 1396.6 | 1393.1 | 1430.7 | 1393.2 | 1380.3 | 1661.8 | 5.98 | .29 | 65.0 | 1/ 5 | 125.0 |
| 12/ 21 | 1.0 | 1275 | 10 | YES | 7.5 | 1291.1 | 1269.4 | 1289.3 | 1265.7 | 1273.3 | 1471.3 | .96 | .29 | 65.0 | 2/ 2 | 75.0 |
| 12/ 22 | 1.0 | 1225 | 10 | NO | - | 1246.5 | 1216.0 | 1239.4 | 1208.5 | 1225.0 | 1399.3 | .99 | .29 | 65.0 | 2/ 5 | 25.0 |
| 12/ 23 | 1.0 | 1250 | 10 | NO | - | 1273.8 | 1243.5 | 1270.0 | 1239.3 | 1256.7 | 1440.4 | 1.02 | .29 | 65.0 | 1/ 3 | 50.0 |
| 12/ 24 | 1.0 | 1250 | 10 | NO | - | 1273.4 | 1241.6 | 1268.4 | 1238.5 | 1254.0 | 1441.0 | 1.00 | .29 | 65.0 | 1/ 3 | 50.0 |
| 12/ 25 | 1.0 | 1250 | 10 | YES | 1.2 | 1271.8 | 1243.5 | 1272.3 | 1242.4 | 1256.4 | 1440.7 | 1.07 | .29 | 65.0 | 1/ 3 | 50.0 |
| 12/ 26 | 1.0 | 1225 | 10 | NO | - | 1240.4 | 1211.5 | 1238.7 | 1207.4 | 1223.4 | 1399.2 | 1.01 | .29 | 65.0 | 2/ 5 | 25.0 |
| 12/ 27 | 1.0 | 1225 | 10 | YES | 13.3 | 1243.2 | 1214.3 | 1240.1 | 1207.4 | 1224.6 | 1404.5 | .99 | .29 | 65.0 | 2/ 5 | 25.0 |
| 12/ 28 | 1.0 | 1200 | 10 | NO | - | 1218.4 | 1193.3 | 1217.0 | 1187.5 | 1204.9 | 1379.8 | 1.00 | .29 | 65.0 | 0/ 6 | 0.0 |
| 12/ 29 | 1.0 | 1200 | 10 | NO | - | 1213.5 | 1194.0 | 1214.1 | 1187.4 | 1200.7 | 1373.6 | 1.00 | .29 | 65.0 | 0/ 6 | 0.0 |
| 12/ 30 | 1.0 | 1200 | 10 | NO | - | 1221.2 | 1194.6 | 1217.5 | 1187.9 | 1198.5 | 1377.1 | 1.00 | .29 | 65.0 | 0/ 6 | 0.0 |
| 12/ 31 | 0.0 | 1350 | 10 | YES | 2.6 | 1372.6 | 1300.3 | 1372.6 | 1298.6 | 1355.0 | 1534.2 | 0.00 | .29 | 65.0 | 1/ 1 | 100.0 |
| 12/ 32 | 0.0 | 1325 | 10 | YES | 2.1 | 1342.5 | 1266.0 | 1343.1 | 1268.3 | 1326.3 | 1497.8 | 0.00 | .29 | 65.0 | 1/ 1 | 75.0 |
| 12/ 33 | 0.0 | 1300 | 10 | NO | - | 1312.9 | 1252.9 | 1319.5 | 1248.5 | 1301.7 | 1471.5 | 0.00 | .29 | 65.0 | 1/ 2 | 50.0 |
| 12/ 34 | 0.0 | 1300 | 10 | YES | 8.1 | 1320.1 | 1243.1 | 1321.6 | 1247.5 | 1303.6 | 1472.8 | 0.00 | .29 | 65.0 | 1/ 2 | 50.0 |
| 12/ 35 | 0.0 | 1275 | 10 | NO | - | 1302.5 | 1215.2 | 1299.0 | 1223.7 | 1279.6 | 1442.1 | 0.00 | .29 | 65.0 | 1/ 3 | 25.0 |
| 12/ 36 | 0.0 | 1275 | 10 | NO | - | 1291.9 | 1217.3 | 1298.0 | 1226.2 | 1275.9 | 1443.2 | 0.00 | .29 | 65.0 | 1/ 3 | 25.0 |
| 12/ 37 | 0.0 | 1275 | 10 | YES | 2.3 | 1293.9 | 1214.6 | 1296.9 | 1223.1 | 1276.9 | 1437.7 | 0.00 | .29 | 65.0 | 1/ 3 | 25.0 |
| 12/ 38 | 0.0 | 1250 | 10 | NO | - | 1272.6 | 1185.9 | 1269.9 | 1193.6 | 1251.2 | 1412.6 | .15 | .29 | 65.0 | 0/ 5 | 0.0 |
| 12/ 39 | 0.0 | 1250 | 10 | NO | - | 1267.7 | 1189.3 | 1273.1 | 1200.3 | 1251.6 | 1410.2 | 0.00 | .29 | 65.0 | 0/ 5 | 0.0 |
| 12/ 40 | 0.0 | 1250 | 10 | NO | - | 1269.6 | 1188.6 | 1272.9 | 1199.6 | 1251.8 | 1413.4 | 0.00 | .29 | 65.0 | 0/ 5 | 0.0 |

# TABLE V-8



F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

JP-4
BARE DUCT
DRIP

| RUN/PT. | --- TEST -- CONDITIONS VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | THERMOCOUPLES T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | --- OVERALL --- LITES / ATTEMPT | M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/ 41 | 2.0 | 1250 | 10 | NO | - | 1266.6 | 1247.9 | 1284.8 | 1252.7 | 1252.2 | 1462.4 | 1.89 | .29 | 65.0 | 1/ 3 | 75.0 |
| 12/ 42 | 2.0 | 1250 | 10 | NO | - | 1271.3 | 1252.4 | 1285.9 | 1249.7 | 1250.1 | 1464.1 | 2.03 | .29 | 65.0 | 1/ 3 | 75.0 |
| 12/ 43 | 1.5 | 1275 | 10 | YES | 4.4 | 1276.5 | 1256.1 | 1285.9 | 1258.6 | 1263.3 | 1465.5 | 1.50 | .29 | 65.0 | 1/ 1 | 75.0 |
| 12/ 44 | 1.5 | 1200 | 10 | NO | - | 1222.6 | 1183.4 | 1228.4 | 1193.1 | 1201.7 | 1392.4 | 1.50 | .29 | 65.0 | 0/ 3 | 0.0 |
| 12/ 45 | 1.5 | 1200 | 10 | NO | - | 1228.2 | 1198.3 | 1228.8 | 1198.7 | 1206.2 | 1396.0 | 1.48 | .29 | 65.0 | 0/ 3 | 0.0 |
| 12/ 46 | 1.5 | 1200 | 10 | NO | - | 1220.8 | 1188.6 | 1230.4 | 1199.3 | 1206.2 | 1395.5 | 1.46 | .29 | 65.0 | 0/ 3 | 0.0 |
| 12/ 47 | 2.0 | 1300 | 10 | YES | 1.6 | 1313.6 | 1291.8 | 1330.5 | 1293.1 | 1297.9 | 1525.7 | 2.02 | 1.70 | 100.0 | 3/ 3 | 125.0 |
| 12/ 48 | 2.0 | 1200 | 10 | YES | 5.2 | 1217.8 | 1190.6 | 1229.3 | 1195.6 | 1199.1 | 1399.5 | 2.01 | 1.70 | 100.0 | 1/ 4 | 25.0 |
| 12/ 49 | 2.0 | 1175 | 10 | NO | - | 1187.2 | 1172.1 | 1201.8 | 73.7 | 1172.2 | 1369.5 | 2.01 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 12/ 50 | 2.0 | 1175 | 10 | NO | - | 1188.3 | 1160.9 | 1203.0 | 71.8 | 1174.5 | 1376.7 | 2.02 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 12/ 51 | 2.0 | 1175 | 10 | NO | - | 1194.7 | 1165.9 | 1206.9 | 73.8 | 1176.4 | 1381.9 | 1.98 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 12/ 52 | 4.0 | 1350 | 10 | YES | 1.8 | 1370.5 | 1359.4 | 1396.5 | 77.5 | 1353.0 | 1627.2 | 3.98 | 1.70 | 100.0 | 3/ 3 | 100.0 |
| 12/ 53 | 4.0 | 1325 | 0 | NO | - | 1343.1 | 1323.4 | 1370.6 | 73.7 | 1323.9 | 1583.3 | 4.00 | 1.70 | 100.0 | 2/ 7 | 75.0 |
| 12/ 54 | 4.0 | 1325 | 10 | NO | - | 1344.6 | 1332.5 | 1367.6 | 77.7 | 1332.0 | 1585.9 | 4.14 | 1.70 | 100.0 | 2/ 7 | 75.0 |
| 12/ 55 | 4.0 | 1325 | 10 | YES | 1.7 | 1345.3 | 1325.5 | 1360.4 | 74.2 | 1320.8 | 1583.1 | 4.07 | 1.70 | 100.0 | 2/ 7 | 75.0 |
| 12/ 56 | 4.0 | 1300 | 10 | NO | - | 1316.1 | 1297.3 | 1334.0 | 74.8 | 1297.9 | 1546.5 | 3.99 | 1.70 | 100.0 | 1/ 5 | 50.0 |
| 12/ 57 | 4.0 | 1300 | 10 | NO | - | 1318.8 | 1294.1 | 1334.4 | 72.9 | 1293.2 | 1548.3 | 4.00 | 1.70 | 100.0 | 1/ 5 | 50.0 |
| 12/ 58 | 4.0 | 1300 | 10 | NO | - | 1316.3 | 1299.0 | 1335.3 | 72.6 | 1296.9 | 1548.1 | 4.03 | 1.70 | 100.0 | 1/ 5 | 50.0 |
| 12/ 59 | 6.0 | 1375 | 10 | NO | - | 1398.6 | 1378.2 | 1422.8 | 75.9 | 1378.0 | 1667.8 | 6.05 | 1.70 | 100.0 | 1/ 5 | 125.0 |
| 12/ 60 | 6.0 | 1375 | 10 | YES | 1.8 | 1396.8 | 1375.0 | 1418.6 | 77.6 | 1374.6 | 1667.6 | 6.04 | 1.70 | 100.0 | 1/ 5 | 125.0 |
| 12/ 61 | 6.0 | 1350 | 10 | NO | - | 1376.8 | 1353.0 | 1402.1 | 76.3 | 1360.4 | 1644.1 | 6.00 | 1.70 | 100.0 | 1/ 2 | 100.0 |
| 12/ 62 | 6.0 | 1350 | 10 | YES | 1.2 | 1374.1 | 1354.7 | 1399.7 | 77.9 | 1359.4 | 1646.6 | 5.98 | 1.70 | 100.0 | 1/ 2 | 100.0 |
| 12/ 63 | 6.0 | 1325 | 10 | YES | 1.7 | 1349.8 | 1330.6 | 1368.3 | 77.0 | 1326.3 | 1600.6 | 5.99 | 1.70 | 100.0 | 1/ 1 | 75.0 |
| 12/ 64 | 6.0 | 1300 | 10 | YES | .9 | 1325.6 | 1291.0 | 1338.5 | 75.8 | 1300.6 | 1566.7 | 6.01 | 1.70 | 100.0 | 1/ 1 | 50.0 |
| 12/ 65 | 6.0 | 1275 | 10 | YES | 1.4 | 1299.7 | 1266.1 | 1316.2 | 75.4 | 1273.8 | 1536.0 | 5.98 | 1.70 | 100.0 | 1/ 1 | 25.0 |
| 12/ 66 | 6.0 | 1250 | 10 | NO | - | 1263.7 | 1240.4 | 1291.5 | 74.4 | 1249.3 | 1501.5 | 5.85 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 12/ 67 | 6.0 | 1250 | 10 | NO | - | 1276.9 | 1242.0 | 1298.5 | 74.3 | 1250.0 | 1511.5 | 5.96 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 12/ 68 | 6.0 | 1250 | 10 | NO | - | 1274.4 | 1235.8 | 1296.5 | 78.5 | 1249.5 | 1510.6 | 6.16 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 12/ 69 | 4.0 | 1350 | 10 | YES | 10.4 | 1376.5 | 1348.6 | 1394.8 | 75.9 | 1352.7 | 1621.5 | 4.08 | 1.70 | 100.0 | 3/ 3 | 100.0 |
| 12/ 70 | 4.0 | 1325 | 10 | YES | 2.8 | 1350.2 | 1318.8 | 1366.6 | 76.7 | 1332.1 | 1588.4 | 3.90 | 1.70 | 100.0 | 2/ 7 | 75.0 |
| 12/ 71 | 4.0 | 1300 | 10 | YES | 2.1 | 1327.2 | 1294.7 | 1343.8 | 79.9 | 1302.6 | 1552.0 | 4.05 | 1.70 | 100.0 | 1/ 5 | 50.0 |
| 12/ 72 | 4.0 | 1275 | 10 | YES | 2.6 | 1296.3 | 1271.4 | 1313.9 | 76.5 | 1272.0 | 1516.7 | 4.06 | 1.70 | 100.0 | 1/ 2 | 25.0 |
| 12/ 73 | 4.0 | 1250 | 10 | NO | - | 1268.8 | 1239.7 | 1286.8 | 79.3 | 1252.1 | 1486.3 | 3.99 | 1.70 | 100.0 | 0/ 5 | 0.0 |
| 12/ 74 | 4.0 | 1250 | 10 | NO | - | 1274.0 | 1241.3 | 1286.6 | 76.1 | 1249.5 | 1487.8 | 3.99 | 1.70 | 100.0 | 0/ 5 | 0.0 |
| 12/ 75 | 4.0 | 1250 | 10 | NO | - | 1272.5 | 1244.7 | 1290.1 | 77.7 | 1248.4 | 1488.4 | 4.04 | 1.70 | 100.0 | 0/ 5 | 0.0 |
| 12/ 76 | 8.0 | 1350 | 10 | YES | 1.5 | 1372.1 | 1337.1 | 1401.1 | 75.8 | 1353.2 | 1656.2 | 7.91 | 1.70 | 100.0 | 1/ 1 | 25.0 |
| 12/ 77 | 8.0 | 1325 | 10 | NO | - | 1345.5 | 1312.1 | 1369.7 | 76.5 | 1324.7 | 1617.2 | 8.08 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 12/ 78 | 8.0 | 1325 | 10 | NO | - | 1346.4 | 1321.3 | 1371.8 | 77.2 | 1323.3 | 1619.8 | 8.07 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 12/ 79 | 8.0 | 1325 | 10 | NO | - | 1347.4 | 1319.2 | 1373.6 | 75.1 | 1327.7 | 1620.9 | 7.91 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 12/ 80 | 1.0 | 1275 | 10 | YES | 3.2 | 1290.7 | 1253.0 | 1281.7 | 73.2 | 1273.6 | 1469.9 | .93 | 1.70 | 100.0 | 2/ 2 | 75.0 |

# TABLE V-8

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

JP-4
BARE DUCT
DRIP

| RUN/PT. | TEST CONDITIONS VEL | TEST CONDITIONS TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | THERMOCOUPLES T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | OVERALL LITES / ATTEMPT | OVERALL M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/ 81 | 1.0 | 1225 | 10 | NO | - | 1238.5 | 1196.4 | 1230.9 | 76.4 | 1225.3 | 1405.7 | 1.01 | 1.70 | 100.0 | 2/ 5 | 25.0 |
| 12/ 82 | 1.0 | 1225 | 10 | YES | 2.0 | 1238.5 | 1198.7 | 1228.6 | 72.6 | 1221.6 | 1402.7 | .95 | 1.70 | 100.0 | 2/ 5 | 25.0 |
| 12/ 83 | 1.0 | 1200 | 10 | NO | - | 1217.4 | 1173.3 | 1205.4 | 75.4 | 1198.2 | 1367.5 | 1.03 | 1.70 | 100.0 | 0/ 6 | 0.0 |
| 12/ 84 | 1.0 | 1200 | 10 | NO | - | 1219.5 | 1177.0 | 1207.2 | 76.0 | 1198.1 | 1372.6 | .95 | 1.70 | 100.0 | 0/ 6 | 0.0 |
| 12/ 85 | 1.0 | 1200 | 10 | NO | - | 1219.5 | 1179.5 | 1206.4 | 73.5 | 1199.8 | 1369.7 | .95 | 1.70 | 100.0 | 0/ 6 | 0.0 |
| 12/ 86 | 0.0 | 1250 | 10 | NO | - | 1272.3 | 1188.2 | 1262.6 | 74.3 | 1252.2 | 1412.0 | 0.00 | 1.70 | 100.0 | 0/ 5 | 0.0 |
| 12/ 87 | 0.0 | 1250 | 10 | NO | - | 1264.0 | 1182.7 | 1265.1 | 75.3 | 1249.7 | 1402.6 | 0.00 | 1.70 | 100.0 | 0/ 5 | 0.0 |
| 12/ 88 | 4.0 | 1250 | 10 | NO | - | 1260.5 | 1238.8 | 1284.5 | 71.9 | 1244.8 | 1471.8 | 4.05 | 1.70 | 100.0 | 0/ 5 | 0.0 |
| 12/ 89 | 4.0 | 1250 | 10 | NO | - | 1267.7 | 1243.5 | 1288.2 | 75.8 | 1250.2 | 1481.9 | 4.04 | 1.70 | 100.0 | 0/ 5 | 0.0 |
| 12/ 90 | 4.0 | 1275 | 10 | NO | - | 1293.3 | 1269.8 | 1312.8 | 76.1 | 1274.6 | 1515.5 | 4.02 | 1.70 | 100.0 | 1/ 2 | 25.0 |

# TABLE / -9

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

JP-4
DUCT & CLAMP
DRIP

| RUN/PT. | --- TEST -- CONDITIONS VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | THERMOCOUPLES T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | --- OVERALL --- LITES / ATTEMPT | M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18/ 1 | 2.0 | 1200 | 10 | YES | 1.8 | 1252.2 | 1246.2 | 1267.4 | 1257.8 | 1205.0 | 1481.1 | 2.04 | 1.70 | 100.0 | 2/ 2 | 250.0 |
| 18/ 2 | 2.0 | 1150 | 10 | YES | 1.6 | 1204.7 | 1200.0 | 1214.7 | 1198.7 | 1161.0 | 1427.7 | 2.06 | 1.70 | 100.0 | 1/ 1 | 200.0 |
| 18/ 3 | 2.0 | 1100 | 10 | YES | 1.9 | 1152.7 | 1148.4 | 1162.9 | 1157.3 | 1112.0 | 1361.1 | 1.96 | 1.70 | 100.0 | 3/ 3 | 150.0 |
| 18/ 4 | 2.0 | 1050 | 10 | YES | 2.7 | 1099.1 | 1096.4 | 1115.8 | 1107.9 | 1060.0 | 1302.4 | 1.97 | 1.70 | 100.0 | 2/ 2 | 100.0 |
| 18/ 5 | 2.0 | 1025 | 10 | YES | 2.6 | 1048.9 | 1052.0 | 1092.2 | 1073.4 | 1013.0 | 1268.0 | 2.03 | 1.70 | 100.0 | 1/ 1 | 75.0 |
| 18/ 6 | 2.0 | 975 | 10 | NO | - | 999.2 | 1003.6 | 1038.3 | 1023.0 | 966.0 | 1194.8 | 2.03 | 1.70 | 100.0 | 1/ 2 | 25.0 |
| 18/ 7 | 2.0 | 975 | 10 | YES | 2.3 | 996.3 | 998.6 | 1050.1 | 1003.2 | 963.0 | 1194.3 | 2.02 | 1.70 | 100.0 | 1/ 2 | 25.0 |
| 18/ 8 | 2.0 | 925 | 10 | NO | - | 953.9 | 957.6 | 992.0 | 967.0 | 919.0 | 1134.7 | 2.03 | 1.70 | 100.0 | 0/ 1 | -25.0 |
| 18/ 9 | 2.0 | 900 | 10 | NO | - | 945.5 | 950.6 | 1003.6 | 948.2 | 911.0 | 1135.0 | 2.06 | 1.70 | 100.0 | 0/ 2 | -50.0 |
| 18/ 10 | 2.0 | 900 | 10 | NO | - | 946.7 | 950.7 | 1003.0 | 957.6 | 911.0 | 1130.2 | 2.10 | 1.70 | 100.0 | 0/ 2 | -50.0 |
| 18/ 11 | 4.0 | 1150 | 10 | YES | 1.7 | 1200.8 | 1202.0 | 1241.0 | 1217.9 | 1158.0 | 1452.5 | 4.02 | 1.70 | 100.0 | 2/ 2 | 100.0 |
| 18/ 12 | 4.0 | 1075 | 0 | NO | - | 1100.2 | 1106.1 | 1140.7 | 1123.2 | 1063.0 | 1335.6 | 4.03 | 1.70 | 100.0 | 0/ 0 | 25.0 |
| 18/ 14 | 2.0 | 1200 | 10 | YES | 1.5 | 1234.2 | 1265.5 | 1241.2 | 1248.2 | 1195.4 | 1466.4 | 2.02 | 1.70 | 100.0 | 2/ 2 | 250.0 |
| 18/ 16 | 2.0 | 1100 | 10 | YES | 1.2 | 1125.6 | 1169.7 | 1151.3 | 1145.9 | 1095.7 | 1345.2 | 2.01 | 1.70 | 100.0 | 3/ 3 | 150.0 |
| 18/ 18 | 2.0 | 1000 | 10 | YES | 3.5 | 1029.1 | 1070.9 | 1060.7 | 1045.5 | 1000.3 | 1227.0 | 2.02 | 1.70 | 100.0 | 1/ 4 | 50.0 |
| 18/ 20 | 2.0 | 950 | 10 | NO | - | 974.7 | 1015.5 | 1009.9 | 986.7 | 944.4 | 1162.5 | 1.98 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 18/ 21 | 2.0 | 950 | 10 | NO | - | 971.4 | 1014.1 | 1027.0 | 976.6 | 942.0 | 1163.5 | 2.04 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 18/ 22 | 2.0 | 950 | 10 | NO | - | 972.1 | 1015.1 | 1027.4 | 985.8 | 948.0 | 1160.8 | 2.02 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 18/ 24 | 4.0 | 1200 | 10 | YES | 1.4 | 1239.8 | 1280.6 | 1277.1 | 1254.3 | 1197.9 | 1497.9 | 3.95 | 1.70 | 100.0 | 1/ 1 | 150.0 |
| 18/ 26 | 4.0 | 1150 | 10 | YES | 3.3 | 1186.4 | 1228.2 | 1225.3 | 1204.8 | 1148.5 | 1440.3 | 4.00 | 1.70 | 100.0 | 2/ 2 | 100.0 |
| 18/ 28 | 4.0 | 1100 | 10 | YES | 4.3 | 1133.7 | 1176.5 | 1175.9 | 1155.2 | 1097.7 | 1377.4 | 4.02 | 1.70 | 100.0 | 1/ 1 | 50.0 |
| 18/ 31 | 4.0 | 1050 | 10 | NO | - | 1082.2 | 1126.7 | 1129.0 | 1097.5 | 1045.9 | 1317.9 | 4.00 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 18/ 32 | 4.0 | 1050 | 10 | NO | - | 1081.1 | 1127.9 | 1138.1 | 1094.1 | 1047.9 | 1321.0 | 4.05 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 18/ 33 | 4.0 | 1050 | 10 | NO | - | 1079.7 | 1126.0 | 1154.1 | 1086.2 | 1046.8 | 1317.7 | 4.02 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 18/ 38 | 6.0 | 1300 | 10 | YES | 1.2 | 1345.5 | 1386.5 | 1366.9 | 1366.5 | 1298.9 | 1651.6 | 5.91 | 1.70 | 100.0 | 1/ 1 | 200.0 |
| 18/ 40 | 6.0 | 1250 | 10 | YES | 1.2 | 1293.4 | 1335.7 | 1327.8 | 1316.1 | 1245.1 | 1589.3 | 5.96 | 1.70 | 100.0 | 1/ 1 | 150.0 |
| 18/ 42 | 6.0 | 1200 | 10 | YES | 3.4 | 1241.0 | 1286.1 | 1283.4 | 1266.8 | 1197.7 | 1525.3 | 6.00 | 1.70 | 100.0 | 1/ 1 | 100.0 |
| 18/ 44 | 6.0 | 1150 | 10 | NO | - | 1186.9 | 1231.6 | 1230.9 | 1216.0 | 1144.8 | 1461.3 | 5.99 | 1.70 | 100.0 | 1/ 2 | 50.0 |
| 18/ 45 | 6.0 | 1150 | 10 | YES | 6.0 | 1190.3 | 1232.6 | 1240.9 | 1214.2 | 1146.0 | 1462.6 | 6.02 | 1.70 | 100.0 | 1/ 2 | 50.0 |
| 18/ 47 | 6.0 | 1100 | 10 | NO | - | 1139.6 | 1185.3 | 1188.2 | 1165.3 | 1099.2 | 1405.1 | 5.93 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 18/ 48 | 6.0 | 1100 | 10 | NO | - | 1132.3 | 1176.5 | 1211.8 | 1149.9 | 1096.6 | 1421.8 | 5.98 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 18/ 49 | 6.0 | 1100 | 10 | NO | - | 1139.5 | 1184.2 | 1203.2 | 1150.7 | 1099.2 | 1404.8 | 5.95 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 18/ 54 | 8.0 | 1300 | 10 | YES | 1.9 | 1349.8 | 1387.7 | 1384.3 | 1372.5 | 1296.5 | 1672.6 | 7.93 | 1.70 | 100.0 | 1/ 1 | 150.0 |
| 18/ 55 | 8.0 | 1200 | 10 | YES | 5.3 | 1245.8 | 1287.1 | 1288.2 | 1271.1 | 1197.9 | 1552.3 | 8.03 | 1.70 | 100.0 | 1/ 1 | 50.0 |
| 18/ 57 | 8.0 | 1150 | 10 | NO | - | 1194.4 | 1232.7 | 1241.2 | 1227.3 | 1147.2 | 1489.6 | 7.94 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 18/ 58 | 8.0 | 1150 | 10 | NO | - | 1194.4 | 1232.5 | 1244.1 | 1228.3 | 1149.6 | 1492.1 | 8.02 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 18/ 59 | 8.0 | 1150 | 10 | NO | - | 1185.6 | 1224.1 | 1259.4 | 1217.3 | 1147.7 | 1496.4 | 7.99 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 20/ 46 | 1.0 | 1200 | 10 | YES | 2.4 | 1235.1 | 1247.3 | 1235.4 | 1236.0 | 1195.9 | 1440.6 | .90 | 1.70 | 100.0 | 1/ 1 | 300.0 |
| 20/ 48 | 1.0 | 1000 | 10 | NO | - | 1025.4 | 1043.2 | 1027.1 | 1029.5 | 997.3 | 1188.3 | .96 | 1.70 | 100.0 | 1/ 2 | 100.0 |
| 20/ 49 | 1.0 | 1100 | 10 | YES | 11.9 | 1131.4 | 1146.1 | 1137.5 | 1134.5 | 1100.5 | 1316.4 | .97 | 1.70 | 100.0 | 1/ 1 | 200.0 |

# TABLE V-9

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

JP-4
DUCT & CLAMP
DRIP

| RUN/PT. | TEST CONDITIONS VEL | TEST CONDITIONS TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | THERMOCOUPLES T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | OVERALL LITES / ATTEMPT | OVERALL M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20/ 50 | 1.0 | 1050 | 10 | YES | 3.3 | 1075.0 | 1090.7 | 1083.0 | 1079.2 | 1045.4 | 1244.4 | 1.02 | 1.70 | 100.0 | 1/ 1 | 150.0 |
| 20/ 51 | 1.0 | 1000 | 10 | YES | 99.9 | 1023.8 | 1042.5 | 1033.7 | 1025.8 | 996.9 | 1187.1 | .99 | 1.70 | 100.0 | 1/ 2 | 100.0 |
| 20/ 52 | 1.0 | 950 | 10 | NO | - | 969.2 | 989.2 | 983.0 | 971.0 | 945.2 | 1126.0 | 1.02 | 1.70 | 100.0 | 1/ 3 | 50.0 |
| 20/ 53 | 1.0 | 950 | 10 | NO | - | 976.5 | 994.8 | 1002.4 | 968.1 | 951.6 | 1132.6 | .92 | 1.70 | 100.0 | 1/ 3 | 50.0 |
| 20/ 54 | 1.0 | 950 | 10 | YES | 6.8 | 969.4 | 988.7 | 1005.0 | 962.8 | 946.2 | 1130.4 | .99 | 1.70 | 100.0 | 1/ 3 | 50.0 |
| 20/ 55 | 1.0 | 900 | 10 | NO | - | 921.9 | 941.4 | 940.7 | 923.6 | 898.7 | 1069.9 | .94 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 20/ 56 | 1.0 | 900 | 10 | NO | - | 920.8 | 943.1 | 952.1 | 917.2 | 899.6 | 1072.1 | .96 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 20/ 57 | 1.0 | 900 | 10 | NO | - | 917.6 | 940.9 | 957.0 | 916.1 | 896.9 | 1068.2 | 1.00 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 20/ 58 | 0.0 | 1300 | 10 | YES | 1.3 | 1333.8 | 1302.4 | 1339.5 | 1316.6 | 1298.2 | 1531.8 | 0.00 | 1.70 | 100.0 | 1/ 1 | 300.0 |
| 20/ 59 | 0.0 | 1200 | 10 | YES | 2.9 | 1232.8 | 1206.2 | 1237.3 | 1218.7 | 1199.1 | 1410.5 | 0.00 | 1.70 | 100.0 | 1/ 1 | 200.0 |
| 20/ 60 | 0.0 | 1100 | 10 | NO | - | 1129.2 | 1108.8 | 1134.4 | 1118.4 | 1101.4 | 1290.2 | .24 | 1.70 | 100.0 | 1/ 2 | 100.0 |
| 20/ 61 | 0.0 | 1100 | 10 | YES | 13.6 | 1125.7 | 1108.5 | 1139.5 | 1116.5 | 1100.1 | 1288.3 | .14 | 1.70 | 100.0 | 1/ 2 | 100.0 |
| 20/ 62 | 0.0 | 1050 | 10 | NO | - | 1073.9 | 1061.6 | 1083.3 | 1065.6 | 1047.4 | 1225.8 | .14 | 1.70 | 100.0 | 1/ 3 | 50.0 |
| 20/ 63 | 0.0 | 1050 | 10 | NO | - | 1071.6 | 1064.8 | 1092.5 | 1062.3 | 1046.5 | 1230.7 | 0.00 | 1.70 | 100.0 | 1/ 3 | 50.0 |
| 20/ 64 | 0.0 | 1050 | 10 | YES | 3.2 | 1070.9 | 1059.8 | 1093.5 | 1060.0 | 1044.9 | 1232.8 | 0.00 | 1.70 | 100.0 | 1/ 3 | 50.0 |
| 20/ 65 | 0.0 | 1000 | 10 | NO | - | 1018.0 | 1010.5 | 1036.6 | 1009.5 | 996.4 | 1168.0 | 0.00 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 20/ 66 | 0.0 | 1000 | 10 | NO | - | 1016.3 | 1012.8 | 1045.5 | 1006.6 | 996.6 | 1169.5 | .24 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 20/ 67 | 0.0 | 1000 | 10 | NO | - | 1018.7 | 1016.0 | 1056.0 | 1008.5 | 998.5 | 1171.7 | .20 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 20/ 68 | 2.0 | 1100 | 10 | YES | 6.9 | 1130.3 | 1163.5 | 1155.9 | 1138.1 | 1094.7 | 1343.4 | 2.02 | .29 | 65.0 | 3/ 3 | 150.0 |
| 20/ 69 | 2.0 | 1050 | 10 | YES | 6.4 | 1077.7 | 1114.4 | 1101.9 | 1089.7 | 1044.4 | 1279.5 | 2.04 | .29 | 65.0 | 2/ 2 | 100.0 |
| 20/ 70 | 2.0 | 1000 | 10 | NO | - | 1024.9 | 1066.7 | 1056.7 | 1036.3 | 995.1 | 1223.3 | 2.04 | .29 | 65.0 | 1/ 4 | 50.0 |
| 20/ 71 | 2.0 | 1000 | 10 | NO | - | 1022.8 | 1064.4 | 1057.3 | 1036.9 | 993.2 | 1218.8 | 2.03 | .29 | 65.0 | 1/ 4 | 50.0 |
| 20/ 72 | 2.0 | 1000 | 10 | NO | - | 1024.8 | 1066.3 | 1058.1 | 1038.0 | 994.6 | 1220.1 | 2.03 | .29 | 65.0 | 1/ 4 | 50.0 |

# TABLE V-10

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

JP-4
OBSTRUCTIONS
DRIP

| RUN/PT. | --- TEST -- CONDITIONS VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | ---- THERMOCOUPLES ---- T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | --- OVERALL --- LITES / ATTEMPT | H.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23/ 1 | 4.0 | 1300 | 10 | YES | .3 | 1329.1 | 1329.1 | 1290.8 | 1312.0 | 1298.7 | 1548.4 | 3.93 | 1.70 | 100.0 | 1/ 1 | 250.0 |
| 23/ 2 | 4.0 | 1100 | 10 | YES | 2.3 | 1119.8 | 1128.5 | 1088.8 | 1108.5 | 1098.9 | 1300.6 | 3.96 | 1.70 | 100.0 | 1/ 1 | 50.0 |
| 23/ 3 | 4.0 | 1050 | 10 | NO | - | 1073.2 | 1079.8 | 1044.1 | 1060.2 | 1052.0 | 1243.7 | 3.99 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 23/ 4 | 4.0 | 1050 | 10 | NO | - | 1067.6 | 1074.3 | 1050.0 | 1057.0 | 1049.5 | 1236.8 | 4.01 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 23/ 5 | 4.0 | 1050 | 10 | NO | - | 1069.0 | 1079.1 | 1055.4 | 1056.8 | 1051.1 | 1238.0 | 4.02 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 23/ 6 | 6.0 | 1300 | 10 | YES | .5 | 1321.4 | 1322.4 | 1286.8 | 1294.3 | 1294.5 | 1541.1 | 6.04 | 1.70 | 100.0 | 1/ 1 | 200.0 |
| 23/ 7 | 6.0 | 1200 | 10 | YES | 2.3 | 1220.7 | 1226.3 | 1177.8 | 1199.8 | 1200.8 | 1421.2 | 6.06 | 1.70 | 100.0 | 1/ 1 | 100.0 |
| 23/ 8 | 6.0 | 1150 | 10 | YES | 2.1 | 1170.6 | 1178.4 | 1129.6 | 1150.8 | 1153.4 | 1365.3 | 6.01 | 1.70 | 100.0 | 1/ 1 | 50.0 |
| 23/ 9 | 6.0 | 1100 | 10 | NO | - | 1113.6 | 1122.3 | 1075.6 | 1099.5 | 1098.8 | 1298.2 | 6.01 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 23/ 10 | 6.0 | 1100 | 10 | NO | - | 1116.6 | 1126.5 | 1089.4 | 1098.4 | 1106.4 | 1302.2 | 6.02 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 23/ 11 | 6.0 | 1100 | 10 | NO | - | 1107.1 | 1114.7 | 1088.3 | 1087.0 | 1092.1 | 1289.8 | 5.95 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 23/ 12 | 8.0 | 1300 | 10 | YES | .9 | 1321.3 | 1319.5 | 1275.2 | 1293.1 | 1298.6 | 1547.7 | 7.99 | 1.70 | 100.0 | 1/ 1 | 150.0 |
| 23/ 13 | 8.0 | 1200 | 10 | YES | 2.9 | 1216.6 | 1222.9 | 1167.7 | 1195.1 | 1199.6 | 1421.7 | 7.96 | 1.70 | 100.0 | 1/ 1 | 50.0 |
| 23/ 14 | 8.0 | 1150 | 10 | NO | - | 1163.9 | 1169.6 | 1117.6 | 1142.9 | 1150.8 | 1366.0 | 8.05 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 23/ 15 | 8.0 | 1150 | 10 | NO | - | 1162.2 | 1169.4 | 1124.4 | 1141.8 | 1148.7 | 1361.8 | 7.96 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 23/ 16 | 8.0 | 1150 | 10 | NO | - | 1167.0 | 1172.5 | 1135.0 | 1145.9 | 1154.2 | 1367.3 | 7.98 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 23/ 17 | 2.0 | 1300 | 10 | YES | 1.0 | 1338.4 | 1335.6 | 1310.0 | 1324.3 | 1301.0 | 1552.0 | 2.03 | 1.70 | 100.0 | 1/ 1 | 400.0 |
| 23/ 18 | 2.0 | 1100 | 10 | YES | 2.4 | 1133.8 | 1134.6 | 1104.7 | 1122.4 | 1103.2 | 1309.9 | 1.99 | 1.70 | 100.0 | 1/ 1 | 200.0 |
| 23/ 19 | 2.0 | 1050 | 10 | YES | 3.5 | 1082.5 | 1085.6 | 1055.3 | 1076.0 | 1054.0 | 1245.4 | 2.00 | 1.70 | 100.0 | 1/ 1 | 150.0 |
| 23/ 20 | 2.0 | 1000 | 10 | YES | 3.0 | 1027.7 | 1034.5 | 1009.2 | 1020.9 | 1001.6 | 1179.7 | 2.01 | 1.70 | 100.0 | 1/ 1 | 100.0 |
| 23/ 21 | 2.0 | 950 | 10 | NO | - | 974.6 | 978.1 | 956.1 | 968.5 | 951.1 | 1114.1 | 1.98 | 1.70 | 100.0 | 1/ 3 | 50.0 |
| 23/ 22 | 2.0 | 950 | 10 | NO | - | 971.7 | 976.7 | 965.8 | 961.9 | 950.5 | 1114.6 | 2.05 | 1.70 | 100.0 | 1/ 3 | 50.0 |
| 23/ 23 | 2.0 | 950 | 10 | YES | 3.7 | 969.5 | 976.2 | 974.9 | 957.1 | 948.5 | 1115.3 | 2.04 | 1.70 | 100.0 | 1/ 3 | 50.0 |
| 23/ 24 | 2.0 | 900 | 10 | NO | - | 919.3 | 927.9 | 914.1 | 912.8 | 900.2 | 1052.0 | 2.02 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 23/ 25 | 2.0 | 900 | 10 | NO | - | 922.2 | 926.1 | 924.5 | 912.8 | 901.2 | 1056.5 | 2.00 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 23/ 26 | 2.0 | 900 | 10 | NO | - | 923.8 | 929.1 | 928.5 | 915.1 | 902.0 | 1060.5 | 1.99 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 23/ 27 | 1.0 | 1100 | 10 | YES | 12.7 | 1132.8 | 1135.2 | 1141.6 | 1115.9 | 1100.2 | 1300.1 | 1.11 | 1.70 | 100.0 | 1/ 1 | 100.0 |
| 23/ 28 | 1.0 | 1050 | 10 | NO | - | 1076.0 | 1083.6 | 1080.0 | 1064.0 | 1048.9 | 1237.4 | .97 | 1.70 | 100.0 | 1/ 4 | 50.0 |
| 23/ 29 | 1.0 | 1050 | 10 | NO | - | 1082.8 | 1083.7 | 1083.5 | 1068.2 | 1050.5 | 1243.0 | .95 | 1.70 | 100.0 | 1/ 4 | 50.0 |
| 23/ 30 | 1.0 | 1050 | 10 | NO | - | 1082.6 | 1085.4 | 1086.8 | 1066.7 | 1053.8 | 1244.6 | .96 | 1.70 | 100.0 | 1/ 4 | 50.0 |
| 23/ 31 | 1.0 | 1050 | 0 | NO | - | 1087.7 | 1086.9 | 1098.7 | 1059.5 | 1053.0 | 1251.2 | 1.00 | 1.70 | 100.0 | 1/ 4 | 50.0 |
| 23/ 32 | 1.0 | 1050 | 10 | YES | 2.8 | 1084.7 | 1087.7 | 1088.3 | 1070.3 | 1054.3 | 1246.9 | .95 | 1.70 | 100.0 | 1/ 4 | 50.0 |
| 23/ 33 | 1.0 | 1000 | 10 | NO | - | 1026.8 | 1030.1 | 1019.0 | 1013.8 | 998.0 | 1178.4 | 1.00 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 23/ 34 | 1.0 | 1000 | 10 | NO | - | 1029.9 | 1034.3 | 1030.2 | 1014.0 | 1001.0 | 1183.9 | 1.01 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 23/ 35 | 1.0 | 1000 | 10 | NO | - | 1026.6 | 1029.4 | 1030.9 | 1009.4 | 998.3 | 1177.4 | 1.03 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 23/ 36 | 0.0 | 1200 | 10 | YES | 2.4 | 1230.2 | 1214.6 | 1227.1 | 1216.5 | 1203.6 | 1420.4 | 0.00 | 1.70 | 100.0 | 1/ 1 | 150.0 |
| 23/ 37 | 0.0 | 1150 | 10 | YES | 3.1 | 1170.7 | 1165.5 | 1166.4 | 1165.2 | 1146.6 | 1339.9 | .14 | 1.70 | 100.0 | 1/ 1 | 100.0 |
| 23/ 38 | 0.0 | 1100 | 10 | YES | 13.1 | 1114.1 | 1109.7 | 1110.6 | 1107.3 | 1090.4 | 1270.5 | .14 | 1.70 | 100.0 | 1/ 1 | 50.0 |
| 23/ 39 | 0.0 | 1050 | 10 | NO | - | 1073.9 | 1068.2 | 1079.2 | 1064.8 | 1046.7 | 1230.5 | 0.00 | 1.70 | 100.0 | 0/ 3 | 0.0 |
| 23/ 40 | 0.0 | 1050 | 10 | NO | - | 1074.9 | 1069.9 | 1087.6 | 1065.0 | 1051.9 | 1227.0 | 0.00 | 1.70 | 100.0 | 0/ 3 | 0.0 |

# TABLE V-10

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

JP-4
OBSTRUCTIONS
DRIP

| RUN/PT. | --- TEST -- CONDITIONS VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | THERMOCOUPLES T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | --- OVERALL --- LITES / ATTEMPT | M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23/ 41 | 0.0 | 1050 | 10 | NO | - | 1075.5 | 1069.1 | 1092.5 | 1063.9 | 1052.5 | 1225.7 | 0.00 | 1.70 | 100.0 | 0/ 3 | 0.0 |

# TABLE V-11

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

MIL-H-83282
BARE DUCT
SPRAY

| RUN/PT. | --- TEST -- CONDITIONS VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | ---- THERMOCOUPLES ---- T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | --- OVERALL --- LITES / ATTEMPT | M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7/ 1 | 2.0 | 1350 | 5 | YES | 5.6 | 1372.3 | 1377.2 | 1413.1 | 1368.6 | 1347.4 | 1579.6 | 2.03 | 8.49 | 101.2 | 1/ 1 | 600.0 |
| 7/ 2 | 2.0 | 1325 | 5 | YES | 5.5 | 1361.0 | 1367.4 | 1397.9 | 1349.9 | 1337.1 | 1564.9 | 1.98 | 8.46 | 100.6 | 2/ 2 | 575.0 |
| 7/ 3 | 2.0 | 1325 | 5 | YES | 5.4 | 1350.3 | 1353.5 | 1390.1 | 1345.5 | 1320.7 | 1545.1 | 1.98 | 8.47 | 100.7 | 2/ 2 | 575.0 |
| 7/ 4 | 2.0 | 1300 | 5 | YES | 5.6 | 1311.9 | 1323.7 | 1356.0 | 1311.2 | 1292.0 | 1506.2 | 2.01 | 8.47 | 100.7 | 1/ 1 | 550.0 |
| 7/ 5 | 2.0 | 1250 | 5 | YES | 5.6 | 1267.1 | 1278.6 | 1312.8 | 1267.7 | 1247.4 | 1447.0 | 1.96 | 8.45 | 100.3 | 1/ 1 | 500.0 |
| 7/ 6 | 2.0 | 1150 | 5 | YES | 5.6 | 1182.4 | 1190.2 | 1230.2 | 1179.2 | 1160.3 | 1340.7 | 1.99 | 8.44 | 99.9 | 1/ 1 | 400.0 |
| 7/ 7 | 2.0 | 1100 | 5 | YES | 5.9 | 1113.4 | 1113.2 | 1158.0 | 1115.0 | 1091.3 | 1258.3 | 1.96 | 8.44 | 99.9 | 1/ 1 | 350.0 |
| 7/ 8 | 2.0 | 1025 | 5 | YES | 5.8 | 1059.2 | 1064.3 | 1107.5 | 1062.6 | 1037.0 | 1189.1 | 1.99 | 8.43 | 99.6 | 1/ 1 | 275.0 |
| 7/ 9 | 2.0 | 1000 | 5 | YES | 5.9 | 1001.8 | 1017.8 | 1058.1 | 1012.9 | 987.7 | 1116.4 | 2.09 | 8.42 | 99.4 | 1/ 1 | 250.0 |
| 7/ 10 | 2.0 | 925 | 5 | NO | - | 956.4 | 976.0 | 1004.4 | 971.6 | 934.0 | 1043.5 | 1.98 | 8.40 | 98.8 | 1/ 2 | 175.0 |
| 7/ 11 | 2.0 | 950 | 5 | YES | 6.3 | 961.4 | 975.4 | 1022.5 | 978.5 | 943.6 | 1060.6 | 2.02 | 8.39 | 98.7 | 1/ 1 | 200.0 |
| 7/ 12 | 2.0 | 925 | 5 | YES | 6.0 | 938.1 | 938.2 | 993.6 | 944.9 | 916.8 | 1027.3 | 1.95 | 8.38 | 98.5 | 1/ 2 | 175.0 |
| 7/ 13 | 2.0 | 900 | 5 | YES | 5.9 | 906.4 | 908.2 | 966.1 | 919.7 | 889.4 | 994.3 | 1.98 | 8.38 | 98.2 | 1/ 1 | 150.0 |
| 7/ 14 | 2.0 | 850 | 5 | YES | 6.2 | 861.4 | 880.2 | 922.5 | 885.2 | 849.2 | 944.3 | 1.95 | 8.38 | 98.3 | 1/ 1 | 100.0 |
| 7/ 15 | 2.0 | 800 | 5 | YES | 5.8 | 802.3 | 815.1 | 865.0 | 824.4 | 790.0 | 877.8 | 2.00 | 8.37 | 98.1 | 1/ 1 | 50.0 |
| 7/ 16 | 2.0 | 750 | 5 | NO | - | 756.0 | 752.0 | 814.0 | 767.6 | 744.2 | 829.8 | 1.88 | 8.37 | 98.0 | 0/ 2 | 0.0 |
| 7/ 17 | 2.0 | 750 | 5 | NO | - | 760.7 | 801.5 | 842.0 | 815.9 | 747.0 | 855.6 | 1.91 | 8.36 | 97.8 | 0/ 2 | 0.0 |
| 7/ 18 | 2.0 | 775 | 5 | NO | - | 786.6 | 791.9 | 852.9 | 807.8 | 774.2 | 867.5 | 1.92 | 8.36 | 97.7 | 1/ 2 | 25.0 |
| 7/ 19 | 2.0 | 775 | 5 | YES | 6.0 | 788.6 | 798.6 | 858.4 | 817.3 | 775.9 | 861.8 | 2.01 | 8.35 | 97.7 | 1/ 2 | 25.0 |
| 7/ 20 | 4.0 | 1100 | 5 | YES | 6.1 | 1120.9 | 1137.7 | 1191.3 | 1143.1 | 1091.3 | 1263.6 | 4.00 | 8.57 | 103.5 | 3/ 5 | 25.0 |
| 7/ 21 | 4.0 | 975 | 5 | NO | - | 999.2 | 1013.0 | 1073.4 | 1022.7 | 984.2 | 1136.6 | 3.97 | 8.55 | 102.8 | 0/ 1 | -100.0 |
| 7/ 22 | 4.0 | 1050 | 5 | NO | - | 1062.1 | 1080.3 | 1142.5 | 1090.9 | 1047.7 | 1203.1 | 4.03 | 8.52 | 102.2 | 0/ 1 | -25.0 |
| 7/ 23 | 4.0 | 1075 | 5 | NO | - | 1084.6 | 1103.9 | 1159.5 | 1107.3 | 1064.8 | 1232.1 | 3.99 | 8.50 | 101.5 | 0/ 6 | 0.0 |
| 7/ 24 | 4.0 | 1075 | 5 | NO | - | 1115.6 | 1123.7 | 1183.7 | 1134.9 | 1087.1 | 1259.0 | 3.95 | 8.48 | 101.0 | 0/ 6 | 0.0 |
| 7/ 25 | 4.0 | 1200 | 5 | YES | 5.5 | 1227.0 | 1243.2 | 1302.6 | 1247.4 | 1201.3 | 1408.2 | 3.98 | 8.46 | 100.6 | 2/ 2 | 125.0 |
| 7/ 27 | 4.0 | 1100 | 5 | YES | 6.2 | 1111.5 | 1125.2 | 1176.6 | 1127.2 | 1092.4 | 1247.2 | 4.09 | 8.35 | 97.6 | 3/ 5 | 25.0 |
| 7/ 28 | 4.0 | 1075 | 5 | NO | - | 1104.1 | 1118.2 | 1171.7 | 1119.3 | 1000.0 | 1252.7 | 4.03 | 8.33 | 96.9 | 0/ 6 | 0.0 |
| 7/ 29 | 4.0 | 1075 | 5 | NO | - | 1092.4 | 1115.0 | 1157.5 | 1109.0 | 1071.7 | 1230.7 | 4.02 | 13.19 | 275.4 | 0/ 6 | 0.0 |
| 7/ 30 | 4.0 | 1100 | 5 | NO | - | 1122.0 | 1133.8 | 1192.9 | 1137.3 | 1098.3 | 1271.2 | 3.94 | 13.17 | 274.6 | 3/ 5 | 25.0 |
| 7/ 31 | 4.0 | 1100 | 5 | NO | - | 1109.3 | 1127.8 | 1183.6 | 1132.7 | 1088.1 | 1242.0 | 3.96 | 13.15 | 273.9 | 3/ 5 | 25.0 |
| 7/ 32 | 4.0 | 1150 | 5 | NO | - | 1172.7 | 1180.0 | 1247.5 | 1192.7 | 1149.8 | 1329.9 | 4.03 | 13.15 | 273.7 | 1/ 3 | 75.0 |
| 7/ 33 | 4.0 | 1150 | 5 | NO | - | 1172.1 | 1196.3 | 1244.4 | 1189.1 | 1152.7 | 1329.9 | 3.96 | 8.67 | 106.3 | 1/ 3 | 75.0 |
| 7/ 34 | 3.0 | 1150 | 5 | YES | 5.6 | 1172.4 | 1198.3 | 1233.3 | 1181.4 | 1146.5 | 1324.8 | 2.97 | 8.71 | 107.2 | 1/ 1 | 200.0 |
| 7/ 35 | 3.0 | 1050 | 5 | NO | - | 1062.7 | 1079.1 | 1121.9 | 1074.3 | 1042.8 | 1187.0 | 3.06 | 8.71 | 107.2 | 1/ 2 | 100.0 |
| 7/ 36 | 3.0 | 1100 | 5 | YES | 5.8 | 1125.2 | 1138.0 | 1190.3 | 1139.3 | 1101.7 | 1266.8 | 3.08 | 8.71 | 107.2 | 1/ 1 | 150.0 |
| 7/ 37 | 3.0 | 1075 | 5 | YES | 7.2 | 1090.6 | 1111.5 | 1153.1 | 1112.4 | 1070.3 | 1220.7 | 3.01 | 8.69 | 106.8 | 2/ 2 | 125.0 |
| 7/ 38 | 3.0 | 1075 | 5 | YES | 5.6 | 1080.1 | 1102.4 | 1154.0 | 1103.9 | 1065.9 | 1223.8 | 2.96 | 8.69 | 106.7 | 2/ 2 | 125.0 |
| 7/ 39 | 3.0 | 1050 | 5 | YES | 5.5 | 1057.1 | 1078.1 | 1131.7 | 1084.5 | 1045.4 | 1187.5 | 2.98 | 8.67 | 106.2 | 1/ 2 | 100.0 |
| 7/ 40 | 3.0 | 1025 | 5 | YES | 6.0 | 1043.3 | 1061.2 | 1112.5 | 1054.3 | 1028.0 | 1165.8 | 3.01 | 8.68 | 106.5 | 1/ 1 | 75.0 |
| 7/ 41 | 3.0 | 1000 | 5 | YES | 5.8 | 1012.1 | 1025.1 | 1081.1 | 1025.9 | 992.5 | 1127.5 | 2.99 | 8.68 | 106.4 | 1/ 1 | 50.0 |

# TABLE V-11



F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

MIL-H-83282
BARE DUCT
SPRAY

| RUN/PT. | TEST CONDITIONS VEL | TEST CONDITIONS TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | THERMOCOUPLES T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | OVERALL LITES / ATTEMPT | OVERALL M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7/ 42 | 3.0 | 975 | 5 | NO | - | 995.6 | 1005.1 | 1062.8 | 1010.8 | 975.2 | 1100.5 | 3.03 | 8.67 | 106.2 | 1/ 3 | 25.0 |
| 7/ 43 | 3.0 | 975 | 5 | YES | 6.0 | 992.2 | 1009.3 | 1068.2 | 1020.2 | 972.0 | 1112.0 | 2.94 | 8.66 | 106.0 | 1/ 3 | 25.0 |
| 7/ 44 | 3.0 | 975 | 5 | NO | - | 989.0 | 1012.4 | 1063.7 | 1020.6 | 973.6 | 1108.7 | 2.97 | 8.65 | 105.6 | 1/ 3 | 25.0 |
| 7/ 45 | 4.0 | 950 | 5 | NO | - | 956.6 | 970.3 | 1033.7 | 986.7 | 940.6 | 1064.0 | 3.97 | 8.65 | 105.5 | 0/ 1 | -125.0 |
| 7/ 46 | 3.0 | 950 | 5 | NO | - | 961.1 | 971.8 | 1033.8 | 984.8 | 947.5 | 1060.3 | 3.03 | 8.66 | 106.0 | 0/ 2 | 0.0 |
| 7/ 47 | 3.0 | 950 | 5 | NO | - | 959.2 | 967.8 | 1034.6 | 986.8 | 942.5 | 1067.5 | 3.03 | 8.62 | 104.9 | 0/ 2 | 0.0 |
| 7/ 48 | 4.0 | 1225 | 5 | YES | 7.4 | 1247.0 | 1268.3 | 1319.6 | 1266.2 | 1223.6 | 1420.4 | 3.98 | 8.63 | 105.1 | 1/ 1 | 150.0 |
| 7/ 49 | 4.0 | 1200 | 5 | YES | 5.6 | 1220.3 | 1247.9 | 1292.2 | 1242.9 | 1201.9 | 1390.0 | 3.96 | 8.62 | 104.7 | 2/ 2 | 125.0 |
| 7/ 50 | 4.0 | 1175 | 5 | YES | 5.6 | 1184.9 | 1208.7 | 1261.5 | 1211.1 | 1169.7 | 1344.4 | 3.95 | 8.59 | 104.1 | 1/ 1 | 100.0 |
| 7/ 51 | 4.0 | 1150 | 5 | YES | 5.7 | 1167.4 | 1184.4 | 1236.3 | 1185.5 | 1145.9 | 1317.5 | 3.93 | 8.60 | 104.4 | 1/ 3 | 75.0 |
| 7/ 52 | 4.0 | 1125 | 5 | YES | 6.7 | 1139.7 | 1161.9 | 1214.3 | 1163.8 | 1126.0 | 1288.7 | 3.92 | 8.61 | 104.5 | 1/ 1 | 50.0 |
| 7/ 53 | 4.0 | 1100 | 5 | YES | 6.6 | 1116.0 | 1127.6 | 1187.4 | 1130.9 | 1095.8 | 1243.4 | 4.07 | 8.60 | 104.4 | 3/ 5 | 25.0 |
| 7/ 54 | 4.0 | 1075 | 5 | NO | - | 1078.6 | 1100.0 | 1158.5 | 1105.5 | 1065.6 | 1202.8 | 4.06 | 8.60 | 104.2 | 0/ 6 | 0.0 |
| 7/ 55 | 4.0 | 1075 | 5 | NO | - | 1087.4 | 1108.0 | 1162.5 | 1109.5 | 1066.1 | 1214.6 | 4.03 | 8.58 | 103.8 | 0/ 6 | 0.0 |
| 7/ 56 | 6.0 | 1350 | 5 | YES | 5.5 | 1371.7 | 1400.5 | 1442.5 | 1391.1 | 1343.9 | 1571.8 | 5.93 | 8.58 | 103.8 | 1/ 1 | 100.0 |
| 7/ 57 | 6.0 | 1325 | 5 | YES | 5.4 | 1355.4 | 1375.7 | 1418.6 | 1363.9 | 1327.4 | 1543.9 | 6.04 | 8.58 | 103.8 | 1/ 1 | 75.0 |
| 7/ 58 | 6.0 | 1300 | 5 | YES | 5.7 | 1318.7 | 1339.1 | 1391.2 | 1336.9 | 1296.3 | 1518.0 | 6.00 | 8.57 | 103.5 | 1/ 1 | 50.0 |
| 7/ 59 | 6.0 | 1275 | 5 | YES | 5.7 | 1300.6 | 1324.4 | 1364.9 | 1315.7 | 1272.4 | 1486.8 | 6.15 | 8.57 | 103.6 | 1/ 1 | 25.0 |
| 7/ 60 | 6.0 | 1250 | 5 | NO | - | 1263.8 | 1289.8 | 1331.2 | 1280.4 | 1240.0 | 1435.7 | 6.01 | 8.57 | 103.4 | 0/ 2 | 0.0 |
| 7/ 61 | 6.0 | 1250 | 5 | NO | - | 1282.4 | 1305.5 | 1349.2 | 1293.8 | 1252.7 | 1460.8 | 5.90 | 8.57 | 103.4 | 0/ 2 | 0.0 |
| 7/ 62 | 8.0 | 1400 | 5 | YES | 5.3 | 1424.3 | 1443.5 | 1489.1 | 1437.8 | 1396.7 | 1646.9 | 7.90 | 8.56 | 103.2 | 1/ 1 | 100.0 |
| 7/ 63 | 8.0 | 1375 | 5 | YES | 5.6 | 1402.5 | 1417.9 | 1466.7 | 1412.2 | 1370.7 | 1625.2 | 7.90 | 8.56 | 103.3 | 1/ 1 | 75.0 |
| 7/ 64 | 8.0 | 1350 | 5 | NO | - | 1375.8 | 1400.9 | 1441.5 | 1395.5 | 1350.7 | 1607.8 | 7.98 | 8.56 | 103.2 | 2/ 3 | 50.0 |
| 7/ 65 | 8.0 | 1350 | 5 | YES | 5.5 | 1373.9 | 1401.7 | 1442.4 | 1385.8 | 1347.8 | 1599.1 | 8.06 | 8.56 | 103.1 | 2/ 3 | 50.0 |
| 7/ 66 | 8.0 | 1350 | 5 | YES | 5.5 | 1366.2 | 1387.0 | 1435.1 | 1383.2 | 1340.5 | 1590.4 | 7.98 | 8.55 | 102.8 | 2/ 3 | 50.0 |
| 7/ 67 | 8.0 | 1325 | 5 | YES | 5.6 | 1348.9 | 1370.7 | 1417.3 | 1364.7 | 1321.0 | 1569.7 | 7.83 | 8.49 | 101.3 | 1/ 1 | 25.0 |
| 7/ 68 | 8.0 | 1300 | 5 | NO | - | 1322.0 | 1344.1 | 1395.4 | 1343.4 | 1299.2 | 1538.0 | 7.99 | 8.54 | 102.6 | 0/ 2 | 0.0 |
| 7/ 69 | 8.0 | 1300 | 5 | NO | - | 1322.2 | 1345.7 | 1398.6 | 1347.2 | 1299.0 | 1543.4 | 7.88 | 8.53 | 102.4 | 0/ 2 | 0.0 |
| 7/ 70 | 1.0 | 825 | 5 | YES | 6.0 | 844.1 | 835.3 | 862.1 | 820.5 | 824.8 | 886.9 | .99 | 8.54 | 102.5 | 1/ 1 | 125.0 |
| 7/ 71 | 1.0 | 800 | 5 | YES | 5.9 | 824.9 | 817.9 | 854.6 | 810.2 | 809.0 | 867.8 | .92 | 8.53 | 102.3 | 1/ 1 | 100.0 |
| 7/ 72 | 1.0 | 775 | 5 | YES | 5.9 | 794.7 | 785.3 | 830.0 | 782.8 | 781.2 | 845.5 | .93 | 8.53 | 102.4 | 1/ 1 | 75.0 |
| 7/ 73 | 1.0 | 750 | 5 | NO | - | 752.6 | 765.0 | 791.8 | 771.1 | 748.6 | 791.4 | .99 | 8.53 | 102.3 | 1/ 2 | 50.0 |
| 7/ 74 | 1.0 | 750 | 5 | YES | 5.9 | 763.1 | 762.4 | 820.8 | 770.4 | 756.3 | 823.9 | 1.06 | 8.51 | 101.9 | 1/ 2 | 50.0 |
| 7/ 75 | 1.0 | 725 | 5 | NO | - | 732.2 | 737.2 | 788.6 | 751.4 | 725.1 | 764.4 | .88 | 8.50 | 101.6 | 1/ 2 | 25.0 |
| 7/ 76 | 1.0 | 725 | 5 | YES | 6.5 | 739.4 | 771.4 | 815.7 | 788.3 | 724.1 | 795.0 | 1.17 | 8.49 | 101.4 | 1/ 2 | 25.0 |
| 7/ 77 | 1.0 | 700 | 5 | NO | - | 713.9 | 714.5 | 773.3 | 733.0 | 705.1 | 745.9 | .96 | 8.49 | 101.3 | 0/ 2 | 0.0 |
| 7/ 78 | 1.0 | 700 | 5 | NO | - | 704.9 | 710.9 | 780.4 | 743.4 | 694.7 | 754.8 | .94 | 8.49 | 101.2 | 0/ 2 | 0.0 |
| 7/ 79 | 0.0 | 1075 | 5 | YES | 5.7 | 1100.3 | 1055.1 | 1154.1 | 1067.6 | 1082.6 | 1143.8 | 0.00 | 8.48 | 101.0 | 1/ 1 | 125.0 |
| 7/ 80 | 0.0 | 1050 | 5 | YES | 10.1 | 1050.8 | 1005.2 | 1107.5 | 1028.2 | 1042.4 | 1081.9 | 0.00 | 8.49 | 101.2 | 1/ 1 | 100.0 |
| 7/ 81 | 0.0 | 1000 | 5 | YES | 99.9 | 1003.3 | 960.2 | 1063.4 | 980.7 | 996.1 | 1032.0 | 0.00 | 8.48 | 101.1 | 1/ 1 | 50.0 |

# TABLE V-11

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

MIL-H-83282
BARE DUCT
SPRAY

| | --- TEST -- CONDITIONS | | | | | ------------- THERMOCOUPLES ------------- | | | | | | | | | --- OVERALL --- | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RUN/PT. | VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | LITES / ATTEMPT | M.I.T. DELTA |
| 7/ 82 | 0.0 | 950 | 5 | NO | - | 961.3 | 913.8 | 999.4 | 922.3 | 952.9 | 975.4 | 0.00 | 8.50 | 101.6 | 0/ 2 | 0.0 |
| 7/ 83 | 0.0 | 950 | 5 | NO | - | 968.0 | 924.0 | 1002.3 | 926.2 | 951.6 | 967.9 | 0.00 | 8.47 | 100.7 | 0/ 2 | 0.0 |

# TABLE V-12

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

MIL-H-83282
DUCT & CLAMP
SPRAY

| RUN/PT. | --- TEST -- CONDITIONS VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | THERMOCOUPLES T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | --- OVERALL --- LITES / ATTEMPT | M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15/ 1 | 2.0 | 1000 | 5 | NO | - | 1053.1 | 1049.2 | 1076.5 | 1059.2 | 1011.0 | 1249.6 | 2.03 | 8.43 | 99.6 | 1/ 2 | 275.0 |
| 15/ 2 | 2.0 | 1000 | 5 | YES | 6.3 | 1052.9 | 1049.8 | 1079.5 | 1044.9 | 1011.0 | 1265.9 | 2.04 | 8.41 | 99.2 | 1/ 2 | 275.0 |
| 15/ 3 | 2.0 | 950 | 5 | YES | 5.9 | 995.3 | 990.2 | 1033.5 | 989.5 | 957.0 | 1193.5 | 1.99 | 8.39 | 98.6 | 1/ 1 | 225.0 |
| 15/ 4 | 2.0 | 900 | 5 | YES | 5.8 | 948.1 | 943.7 | 1008.8 | 956.4 | 910.0 | 1167.1 | 2.07 | 8.33 | 97.2 | 1/ 1 | 175.0 |
| 15/ 5 | 2.0 | 850 | 5 | YES | 6.2 | 900.7 | 894.7 | 969.2 | 912.0 | 861.0 | 1108.0 | 2.02 | 8.31 | 96.4 | 1/ 1 | 125.0 |
| 15/ 6 | 2.0 | 825 | 5 | NO | - | 857.4 | 853.2 | 908.1 | 855.8 | 823.0 | 1026.3 | 1.98 | 8.29 | 96.1 | 1/ 9 | 100.0 |
| 15/ 7 | 2.0 | 825 | 5 | NO | - | 854.0 | 859.2 | 922.9 | 782.3 | 818.0 | 1043.3 | 1.99 | 8.29 | 96.0 | 1/ 9 | 100.0 |
| 15/ 8 | 2.0 | 825 | 5 | NO | - | 849.3 | 844.1 | 904.6 | 841.0 | 816.0 | 1010.7 | 2.04 | 8.25 | 95.0 | 1/ 9 | 100.0 |
| 15/ 9 | 2.0 | 825 | 5 | NO | - | 853.6 | 846.6 | 898.3 | 842.0 | 822.0 | 1003.0 | 1.98 | 8.51 | 101.8 | 1/ 9 | 100.0 |
| 15/ 10 | 2.0 | 825 | 5 | NO | - | 850.3 | 848.9 | 899.1 | 843.7 | 818.0 | 1024.0 | 2.03 | 8.48 | 101.1 | 1/ 9 | 100.0 |
| 15/ 11 | 2.0 | 825 | 5 | NO | - | 859.3 | 856.3 | 897.5 | 847.5 | 827.0 | 1020.5 | 2.05 | 6.33 | 50.3 | 1/ 9 | 100.0 |
| 15/ 12 | 2.0 | 825 | 10 | NO | - | 853.5 | 850.9 | 884.5 | 837.6 | 822.0 | 1008.8 | 2.04 | 6.33 | 50.4 | 1/ 9 | 100.0 |
| 15/ 13 | 2.0 | 825 | 3 | NO | - | 852.2 | 850.4 | 900.2 | 840.2 | 822.0 | 1008.1 | 2.01 | 6.33 | 50.2 | 1/ 9 | 100.0 |
| 15/ 14 | 1.5 | 825 | 5 | NO | - | 852.4 | 846.3 | 877.4 | 842.3 | 822.0 | 1001.3 | 1.51 | 6.31 | 49.9 | 0/ 2 | 100.0 |
| 15/ 15 | 1.5 | 925 | 5 | YES | 5.8 | 954.2 | 946.5 | 990.4 | 940.1 | 920.0 | 1123.8 | 1.48 | 6.30 | 49.6 | 4/ 4 | 200.0 |
| 15/ 16 | 1.5 | 875 | 5 | YES | 5.9 | 902.9 | 895.4 | 943.4 | 908.4 | 867.0 | 1068.0 | 1.44 | 6.29 | 49.6 | 1/ 1 | 150.0 |
| 15/ 17 | 1.5 | 825 | 5 | NO | - | 851.8 | 844.1 | 892.3 | 853.6 | 818.0 | 1011.7 | 1.48 | 6.28 | 49.2 | 0/ 2 | 100.0 |
| 15/ 18 | 1.5 | 775 | 5 | NO | - | 804.8 | 798.2 | 833.7 | 808.1 | 771.0 | 947.6 | 1.53 | 6.27 | 49.1 | 1/13 | 50.0 |
| 15/ 19 | 1.5 | 775 | 5 | NO | - | 803.8 | 800.4 | 844.5 | 804.0 | 773.0 | 958.3 | 1.53 | 6.27 | 49.0 | 1/13 | 50.0 |
| 15/ 20 | 1.5 | 775 | 5 | NO | - | 804.2 | 801.8 | 852.5 | 794.8 | 772.0 | 955.6 | 1.47 | 6.26 | 48.8 | 1/13 | 50.0 |
| 15/ 21 | 1.5 | 925 | 5 | YES | 6.0 | 950.3 | 942.5 | 996.0 | 959.1 | 913.0 | 1136.4 | 1.47 | 8.35 | 97.5 | 4/ 4 | 200.0 |
| 15/ 22 | 1.5 | 775 | 5 | NO | - | 802.8 | 795.7 | 838.2 | 804.8 | 772.0 | 947.9 | 1.45 | 8.23 | 94.4 | 1/13 | 50.0 |
| 15/ 23 | 1.5 | 775 | 5 | NO | - | 807.4 | 804.5 | 844.4 | 794.5 | 776.0 | 949.0 | 1.52 | 8.20 | 93.6 | 1/13 | 50.0 |
| 15/ 24 | 1.5 | 775 | 5 | NO | - | 802.8 | 799.4 | 850.2 | 798.0 | 775.0 | 946.0 | 1.48 | 8.16 | 92.7 | 1/13 | 50.0 |
| 15/ 25 | 1.5 | 925 | 5 | YES | 6.0 | 966.0 | 959.3 | 1022.0 | 974.8 | 927.0 | 1161.6 | 1.48 | 5.00 | 24.5 | 4/ 4 | 200.0 |
| 15/ 26 | 1.5 | 775 | 5 | NO | - | 808.6 | 799.7 | 839.1 | 800.5 | 776.0 | 945.2 | 1.54 | 5.00 | 24.5 | 1/13 | 50.0 |
| 15/ 27 | 1.5 | 775 | 5 | NO | - | 807.3 | 801.8 | 840.6 | 799.6 | 775.0 | 943.4 | 1.43 | 5.01 | 24.7 | 1/13 | 50.0 |
| 15/ 28 | 1.5 | 775 | 5 | NO | - | 806.6 | 801.7 | 846.0 | 797.9 | 775.0 | 947.4 | 1.54 | 5.01 | 24.6 | 1/13 | 50.0 |
| 15/ 29 | 1.5 | 925 | 5 | YES | 5.7 | 954.7 | 947.0 | 994.9 | 950.8 | 918.0 | 1130.8 | 1.47 | 14.88 | 353.5 | 4/ 4 | 200.0 |
| 15/ 30 | 1.5 | 775 | 5 | NO | - | 805.1 | 796.9 | 841.0 | 797.9 | 775.0 | 939.0 | 1.52 | 14.96 | 356.9 | 1/13 | 50.0 |
| 15/ 31 | 1.5 | 775 | 5 | NO | - | 806.3 | 802.9 | 863.4 | 800.9 | 772.0 | 945.1 | 1.47 | 14.92 | 355.4 | 1/13 | 50.0 |
| 15/ 32 | 1.5 | 775 | 5 | NO | - | 810.6 | 801.4 | 859.8 | 797.9 | 780.0 | 934.9 | 1.49 | 14.87 | 352.9 | 1/13 | 50.0 |
| 15/ 33 | 1.5 | 775 | 3 | YES | 3.8 | 811.4 | 806.4 | 871.4 | 803.9 | 779.0 | 936.1 | 1.50 | 14.83 | 351.1 | 1/13 | 50.0 |
| 15/ 34 | 1.5 | 725 | 3 | NO | - | 754.1 | 746.7 | 765.8 | 735.1 | 726.0 | 876.6 | 1.51 | 13.78 | 302.9 | 0/ 3 | 0.0 |
| 15/ 35 | 1.5 | 725 | 3 | NO | - | 751.3 | 743.9 | 780.1 | 746.6 | 724.0 | 885.9 | 1.53 | 13.74 | 301.0 | 0/ 3 | 0.0 |
| 15/ 36 | 1.5 | 725 | 3 | NO | - | 750.0 | 744.1 | 790.9 | 746.9 | 723.0 | 893.9 | 1.52 | 13.70 | 299.1 | 0/ 3 | 0.0 |
| 15/ 37 | 3.0 | 1075 | 5 | YES | 5.6 | 1106.8 | 1103.1 | 1144.7 | 1093.9 | 1065.0 | 1329.0 | 3.00 | 13.61 | 294.8 | 1/ 1 | 300.0 |
| 15/ 38 | 3.0 | 1025 | 5 | YES | 6.0 | 1053.2 | 1046.7 | 1109.4 | 1039.9 | 1013.0 | 1275.6 | 3.01 | 13.55 | 292.4 | 1/ 1 | 250.0 |
| 15/ 39 | 3.0 | 975 | 5 | YES | 6.2 | 1004.0 | 997.6 | 1061.4 | 993.2 | 964.0 | 1203.3 | 3.00 | 13.52 | 290.7 | 1/ 1 | 200.0 |
| 15/ 40 | 3.0 | 925 | 5 | YES | 6.1 | 949.5 | 944.5 | 1014.2 | 947.0 | 913.0 | 1137.0 | 2.99 | 13.49 | 289.2 | 1/ 1 | 150.0 |

# TABLE V-12

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

MIL-H-83282
DUCT & CLAMP
SPRAY

| RUN/PT. | --- TEST -- CONDITIONS VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | THERMOCOUPLES T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | --- OVERALL --- LITES / ATTEMPT | M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15/ 41 | 3.0 | 875 | 5 | NO | - | 903.4 | 897.5 | 966.5 | 892.5 | 869.0 | 1075.2 | 3.01 | 13.44 | 287.2 | 1/ 6 | 100.0 |
| 15/ 42 | 3.0 | 875 | 5 | NO | - | 903.2 | 897.9 | 975.6 | 896.0 | 867.0 | 1078.7 | 2.98 | 13.41 | 285.6 | 1/ 6 | 100.0 |
| 15/ 43 | 3.0 | 875 | 5 | NO | - | 909.2 | 908.7 | 988.9 | 902.4 | 877.0 | 1067.7 | 3.04 | 13.39 | 284.6 | 1/ 6 | 100.0 |
| 15/ 44 | 3.0 | 875 | 3 | NO | - | 906.3 | 900.7 | 980.8 | 893.9 | 872.0 | 1058.4 | 2.99 | 13.35 | 282.8 | 1/ 6 | 100.0 |
| 15/ 45 | 3.0 | 875 | 3 | NO | - | 900.8 | 895.5 | 929.8 | 892.2 | 867.0 | 1087.5 | 3.05 | 14.73 | 346.8 | 1/ 6 | 100.0 |
| 15/ 46 | 3.0 | 1050 | 3 | YES | 3.5 | 1095.6 | 1090.2 | 1144.7 | 1104.0 | 1056.0 | 1316.2 | 3.03 | 14.72 | 346.4 | 1/ 1 | 275.0 |
| 15/ 47 | 3.0 | 875 | 3 | YES | 3.6 | 905.1 | 899.2 | 954.3 | 903.3 | 871.0 | 1092.6 | 3.06 | 14.70 | 345.2 | 1/ 6 | 100.0 |
| 15/ 48 | 3.0 | 825 | 3 | YES | 3.8 | 853.3 | 848.7 | 904.3 | 852.3 | 820.0 | 1023.1 | 2.99 | 14.68 | 344.3 | 1/ 1 | 50.0 |
| 15/ 49 | 3.0 | 775 | 3 | NO | - | 809.2 | 804.7 | 862.2 | 802.2 | 777.0 | 965.2 | 3.01 | 14.68 | 344.3 | 0/ 3 | 0.0 |
| 15/ 50 | 3.0 | 775 | 3 | NO | - | 801.3 | 794.6 | 855.7 | 793.7 | 772.0 | 955.8 | 2.97 | 14.67 | 343.8 | 0/ 3 | 0.0 |
| 15/ 51 | 3.0 | 775 | 3 | NO | - | 800.8 | 796.8 | 869.3 | 801.2 | 770.0 | 946.0 | 2.95 | 14.66 | 343.5 | 0/ 3 | 0.0 |
| 15/ 52 | 4.0 | 1250 | 5 | YES | 5.4 | 1290.2 | 1288.0 | 1308.5 | 1285.9 | 1245.0 | 1547.8 | 3.98 | 15.79 | 393.3 | 1/ 1 | 325.0 |
| 15/ 53 | 4.0 | 1150 | 5 | YES | 5.6 | 1190.6 | 1191.8 | 1247.3 | 1217.0 | 1152.0 | 1463.5 | 3.94 | 15.81 | 394.1 | 1/ 1 | 225.0 |
| 15/ 54 | 4.0 | 1050 | 5 | YES | 5.7 | 1096.2 | 1098.2 | 1171.7 | 1129.8 | 1057.0 | 1358.4 | 4.03 | 15.80 | 393.6 | 3/ 3 | 125.0 |
| 15/ 55 | 4.0 | 975 | 5 | NO | - | 1002.0 | 1006.1 | 1055.7 | 1009.8 | 969.0 | 1222.1 | 4.10 | 15.83 | 394.8 | 1/ 7 | 50.0 |
| 15/ 56 | 4.0 | 1050 | 5 | YES | 5.7 | 1096.2 | 1098.5 | 1162.2 | 1108.3 | 1057.0 | 1337.5 | 4.03 | 15.82 | 394.7 | 3/ 3 | 125.0 |
| 15/ 57 | 4.0 | 1000 | 5 | NO | - | 1044.4 | 1047.4 | 1112.3 | 1056.2 | 1008.0 | 1271.6 | 4.03 | 15.83 | 394.9 | 1/ 3 | 75.0 |
| 15/ 58 | 4.0 | 1000 | 5 | NO | - | 1045.8 | 1050.4 | 1129.9 | 1043.5 | 1010.0 | 1275.0 | 4.01 | 15.81 | 394.3 | 1/ 3 | 75.0 |
| 15/ 59 | 4.0 | 1025 | 5 | NO | - | 1051.6 | 1054.2 | 1127.6 | 1055.4 | 1013.0 | 1273.5 | 4.04 | 15.83 | 395.1 | 0/ 1 | 100.0 |
| 15/ 60 | 4.0 | 1000 | 3 | YES | 3.6 | 1048.6 | 1052.2 | 1139.2 | 1041.7 | 1011.0 | 1274.1 | 4.03 | 15.82 | 394.5 | 1/ 3 | 75.0 |
| 15/ 61 | 4.0 | 975 | 3 | NO | - | 1000.0 | 1002.5 | 1070.6 | 999.2 | 964.0 | 1214.7 | 4.01 | 15.83 | 395.1 | 1/ 7 | 50.0 |
| 15/ 62 | 4.0 | 975 | 3 | NO | - | 938.3 | 1004.1 | 1080.6 | 998.3 | 963.0 | 1219.6 | 4.01 | 15.82 | 394.7 | 1/ 7 | 50.0 |
| 15/ 63 | 4.0 | 975 | 3 | NO | - | 1000.2 | 1002.9 | 1069.5 | 1002.0 | 963.0 | 1212.3 | 4.00 | 15.84 | 395.3 | 1/ 7 | 50.0 |
| 15/ 64 | 4.0 | 975 | 2 | NO | - | 998.7 | 1004.0 | 1081.1 | 993.8 | 963.0 | 1220.3 | 3.93 | 15.83 | 394.9 | 1/ 7 | 50.0 |
| 15/ 65 | 4.0 | 975 | 2 | NO | - | 999.4 | 1001.7 | 1049.2 | 1003.1 | 963.0 | 1213.5 | 3.99 | 14.32 | 327.9 | 1/ 7 | 50.0 |
| 15/ 66 | 4.0 | 1050 | 3 | YES | 3.6 | 1098.5 | 1100.9 | 1154.0 | 1098.0 | 1059.0 | 1332.9 | 4.01 | 14.30 | 327.1 | 3/ 3 | 125.0 |
| 15/ 67 | 4.0 | 975 | 3 | YES | 3.7 | 998.3 | 1002.0 | 1060.1 | 1003.1 | 963.0 | 1213.5 | 3.99 | 14.28 | 325.9 | 1/ 7 | 50.0 |
| 15/ 68 | 4.0 | 925 | 3 | NO | - | 947.2 | 948.9 | 1012.9 | 948.9 | 913.0 | 1152.9 | 4.01 | 14.27 | 325.4 | 0/ 3 | 0.0 |
| 15/ 69 | 4.0 | 925 | 3 | NO | - | 948.0 | 951.7 | 1027.1 | 948.6 | 913.0 | 1159.9 | 4.00 | 14.25 | 324.9 | 0/ 3 | 0.0 |
| 15/ 70 | 4.0 | 925 | 3 | NO | - | 948.4 | 950.2 | 1026.4 | 950.9 | 913.0 | 1154.5 | 4.01 | 14.25 | 324.5 | 0/ 3 | 0.0 |
| 15/ 71 | 2.0 | 925 | 3 | YES | 3.7 | 945.8 | 946.4 | 1013.7 | 942.8 | 913.0 | 1128.9 | 2.00 | 14.25 | 324.5 | 1/ 1 | 200.0 |
| 15/ 72 | 2.0 | 825 | 3 | YES | 3.9 | 846.7 | 849.3 | 900.0 | 845.2 | 818.0 | 1008.3 | 2.02 | 14.25 | 324.7 | 1/ 9 | 100.0 |
| 15/ 73 | 2.0 | 775 | 3 | NO | - | 797.7 | 802.2 | 847.5 | 798.6 | 770.0 | 942.3 | 2.03 | 14.24 | 324.3 | 1/ 2 | 50.0 |
| 15/ 74 | 2.0 | 775 | 3 | YES | 4.2 | 792.1 | 803.9 | 859.3 | 799.8 | 768.0 | 943.2 | 2.03 | 14.23 | 323.8 | 1/ 2 | 50.0 |
| 15/ 75 | 2.0 | 725 | 3 | NO | - | 747.6 | 752.3 | 804.0 | 749.1 | 720.0 | 886.1 | 2.04 | 14.23 | 323.7 | 0/ 4 | 0.0 |
| 15/ 76 | 2.0 | 725 | 3 | NO | - | 748.8 | 755.0 | 817.8 | 750.9 | 722.0 | 890.8 | 2.01 | 14.23 | 323.6 | 0/ 4 | 0.0 |
| 15/ 77 | 2.0 | 725 | 3 | NO | - | 750.4 | 756.9 | 825.8 | 754.9 | 724.0 | 891.3 | 2.00 | 14.22 | 323.4 | 0/ 4 | 0.0 |
| 15/ 78 | 2.0 | 725 | 2 | NO | - | 752.2 | 758.5 | 828.2 | 754.0 | 726.0 | 886.4 | 2.02 | 14.22 | 323.2 | 0/ 4 | 0.0 |
| 15/ 79 | 6.0 | 1250 | 5 | YES | 5.3 | 1296.0 | 1295.8 | 1346.2 | 1307.1 | 1252.0 | 1563.1 | 6.00 | 14.23 | 323.9 | 2/ 2 | 200.0 |
| 15/ 80 | 6.0 | 1200 | 5 | YES | 5.5 | 1243.3 | 1242.2 | 1301.8 | 1257.3 | 1199.0 | 1527.1 | 6.02 | 14.22 | 323.5 | 2/ 2 | 150.0 |

# TABLE V-12

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

MIL-H-83282
DUCT & CLAMP
SPRAY

| RUN/PT. | --- TEST -- CONDITIONS VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | THERMOCOUPLES T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | --- OVERALL --- LITES / ATTEMPT | M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15/ 81 | 6.0 | 1150 | 5 | YES | 5.5 | 1198.3 | 1200.3 | 1249.2 | 1212.1 | 1158.0 | 1471.2 | 6.05 | 14.23 | 323.6 | 2/ 2 | 100.0 |
| 15/ 82 | 6.0 | 1100 | 5 | NO | - | 1145.2 | 1147.9 | 1200.6 | 1154.2 | 1106.0 | 1389.5 | 6.07 | 14.22 | 323.2 | 1/ 2 | 50.0 |
| 15/ 83 | 6.0 | 1100 | 5 | YES | 5.8 | 1146.2 | 1148.2 | 1209.4 | 1152.6 | 1106.0 | 1391.8 | 6.06 | 14.21 | 322.7 | 1/ 2 | 50.0 |
| 15/ 84 | 6.0 | 1075 | 0 | NO | - | 1102.5 | 1108.9 | 1172.2 | 1110.4 | 1064.0 | 1341.1 | 5.98 | 14.21 | 322.9 | 0/ 0 | 25.0 |
| 15/ 85 | 6.0 | 1050 | 5 | NO | - | 1099.1 | 1102.0 | 1182.1 | 1102.1 | 1059.0 | 1336.9 | 5.97 | 14.20 | 322.6 | 0/ 5 | 0.0 |
| 15/ 86 | 6.0 | 1050 | 5 | NO | - | 1099.8 | 1105.2 | 1193.4 | 1092.8 | 1060.0 | 1344.2 | 5.94 | 14.20 | 322.2 | 0/ 5 | 0.0 |
| 15/ 87 | 6.0 | 1075 | 0 | NO | - | 1101.9 | 1105.1 | 1168.9 | 1112.3 | 1063.0 | 1338.8 | 6.06 | 14.22 | 323.3 | 0/ 0 | 25.0 |
| 15/ 88 | 6.0 | 1150 | 3 | YES | 3.5 | 1202.6 | 1205.4 | 1277.9 | 1181.9 | 1160.0 | 1460.3 | 6.02 | 14.22 | 323.1 | 2/ 2 | 100.0 |
| 15/ 89 | 6.0 | 1050 | 3 | NO | - | 1097.0 | 1100.3 | 1159.4 | 1100.6 | 1057.0 | 1334.2 | 6.03 | 14.23 | 323.6 | 0/ 5 | 0.0 |
| 15/ 90 | 6.0 | 1200 | 3 | YES | 3.5 | 1249.6 | 1249.3 | 1309.4 | 1253.6 | 1207.0 | 1532.0 | 5.99 | 15.78 | 393.0 | 2/ 2 | 150.0 |
| 15/ 91 | 6.0 | 1050 | 3 | NO | - | 1097.2 | 1099.4 | 1156.1 | 1113.9 | 1059.0 | 1357.0 | 6.00 | 15.78 | 392.7 | 0/ 5 | 0.0 |
| 15/ 92 | 6.0 | 1075 | 0 | NO | - | 1102.0 | 1108.5 | 1178.3 | 1075.6 | 1063.0 | 1369.7 | 6.05 | 15.77 | 392.2 | 0/ 0 | 25.0 |
| 15/ 93 | 6.0 | 1075 | 0 | NO | - | 1102.8 | 1106.0 | 1184.5 | 1104.0 | 1064.0 | 1366.0 | 6.03 | 15.77 | 392.4 | 0/ 0 | 25.0 |
| 15/ 94 | 8.0 | 1225 | 3 | NO | - | 1257.9 | 1256.2 | 1340.7 | 1258.9 | 1213.0 | 1566.4 | 7.97 | 15.78 | 392.9 | 0/ 1 | 175.0 |
| 15/ 95 | 8.0 | 1300 | 5 | YES | 5.4 | 1345.3 | 1342.4 | 1400.2 | 1365.1 | 1297.0 | 1658.4 | 8.01 | 15.79 | 393.0 | 1/ 1 | 250.0 |
| 15/ 96 | 8.0 | 1250 | 5 | YES | 5.3 | 1297.9 | 1297.0 | 1353.3 | 1313.7 | 1253.0 | 1601.4 | 8.00 | 15.78 | 392.9 | 3/ 3 | 200.0 |
| 15/ 97 | 8.0 | 1200 | 5 | YES | 6.3 | 1242.4 | 1242.1 | 1307.7 | 1260.4 | 1198.0 | 1539.7 | 8.02 | 15.79 | 393.1 | 1/ 1 | 150.0 |
| 15/ 98 | 8.0 | 1150 | 5 | NO | - | 1194.4 | 1195.5 | 1270.5 | 1209.7 | 1152.0 | 1489.4 | 8.00 | 15.77 | 392.5 | 1/ 3 | 100.0 |
| 15/ 99 | 8.0 | 1150 | 5 | NO | - | 1202.5 | 1202.0 | 1277.0 | 1217.0 | 1160.0 | 1491.7 | 8.03 | 15.78 | 392.9 | 1/ 3 | 100.0 |
| 15/100 | 8.0 | 1150 | 5 | YES | 5.8 | 1196.1 | 1195.9 | 1274.2 | 1210.2 | 1155.0 | 1490.2 | 7.95 | 15.78 | 393.0 | 1/ 3 | 100.0 |
| 15/101 | 8.0 | 1100 | 5 | NO | - | 1143.7 | 1147.7 | 1211.2 | 1162.3 | 1105.0 | 1425.3 | 7.94 | 15.80 | 393.6 | 1/ 2 | 50.0 |
| 15/102 | 8.0 | 1100 | 5 | YES | 5.9 | 1145.9 | 1148.1 | 1220.9 | 1159.3 | 1104.0 | 1426.6 | 8.03 | 15.79 | 393.2 | 1/ 2 | 50.0 |
| 15/103 | 0.0 | 1050 | 5 | NO | - | 1097.6 | 1101.3 | 1168.1 | 1116.1 | 1059.0 | 1370.4 | 8.00 | 15.80 | 393.5 | 0/ 5 | 0.0 |
| 15/104 | 8.0 | 1050 | 5 | NO | - | 1101.1 | 1103.3 | 1175.0 | 1098.8 | 1060.0 | 1372.7 | 8.01 | 15.79 | 393.1 | 0/ 5 | 0.0 |
| 15/105 | 8.0 | 1050 | 5 | NO | - | 1097.4 | 1100.4 | 1183.7 | 1109.8 | 1058.0 | 1369.5 | 8.05 | 15.79 | 393.2 | 0/ 5 | 0.0 |
| 15/106 | 8.0 | 1050 | 3 | NO | - | 1096.3 | 1098.3 | 1184.3 | 1106.3 | 1056.0 | 1363.2 | 7.95 | 15.79 | 393.2 | 0/ 5 | 0.0 |
| 15/107 | 8.0 | 1250 | 3 | YES | 5.5 | 1298.2 | 1296.4 | 1377.2 | 1303.2 | 1251.0 | 1600.0 | 7.99 | 15.80 | 393.5 | 3/ 3 | 200.0 |
| 15/108 | 8.0 | 1250 | 5 | YES | 5.5 | 1296.4 | 1295.8 | 1355.5 | 1315.5 | 1251.0 | 1604.5 | 7.94 | 15.80 | 393.6 | 3/ 3 | 200.0 |
| 15/109 | 8.0 | 1050 | 3 | NO | - | 1101.2 | 1105.5 | 1165.0 | 1117.7 | 1061.0 | 1377.9 | 8.10 | 15.80 | 393.8 | 0/ 5 | 0.0 |
| 15/110 | 6.0 | 1250 | 3 | YES | 3.4 | 1294.4 | 1293.6 | 1368.4 | 1308.2 | 1248.0 | 1581.2 | 5.99 | 15.82 | 394.6 | 2/ 2 | 200.0 |
| 15/111 | 6.0 | 1050 | 3 | NO | - | 1098.2 | 1102.3 | 1162.9 | 1114.3 | 1060.0 | 1355.2 | 5.98 | 15.80 | 393.5 | 0/ 5 | 0.0 |
| 15/112 | 5.0 | 1150 | 5 | YES | 5.4 | 1196.4 | 1199.7 | 1238.2 | 1207.5 | 1154.0 | 1455.1 | 5.04 | 14.35 | 329.5 | 1/ 1 | 175.0 |
| 15/113 | 5.0 | 1050 | 5 | YES | 5.6 | 1099.5 | 1101.1 | 1158.2 | 1110.6 | 1061.0 | 1341.5 | 4.90 | 14.35 | 329.4 | 1/ 1 | 75.0 |
| 15/114 | 5.0 | 1000 | 5 | NO | - | 1045.1 | 1047.3 | 1115.3 | 1057.9 | 1008.0 | 1281.4 | 4.93 | 14.34 | 328.8 | 1/ 4 | 25.0 |
| 15/115 | 5.0 | 1000 | 5 | NO | - | 1048.4 | 1049.9 | 1121.1 | 1059.8 | 1012.0 | 1280.7 | 4.98 | 14.32 | 328.2 | 1/ 4 | 25.0 |
| 15/116 | 5.0 | 1000 | 5 | NO | - | 1049.6 | 1052.0 | 1128.2 | 1045.1 | 1010.0 | 1278.2 | 5.00 | 14.31 | 327.7 | 1/ 4 | 25.0 |
| 15/117 | 5.0 | 1000 | 3 | YES | 3.7 | 1048.6 | 1053.2 | 1140.2 | 1027.1 | 1011.0 | 1279.4 | 5.00 | 14.30 | 326.8 | 1/ 4 | 25.0 |
| 15/118 | 5.0 | 975 | 3 | NO | - | 998.2 | 1002.3 | 1087.7 | 1007.1 | 963.0 | 1221.6 | 5.00 | 14.30 | 326.9 | 0/ 3 | 0.0 |
| 15/119 | 5.0 | 975 | 3 | NO | - | 1008.0 | 1013.2 | 1098.3 | 1015.8 | 972.0 | 1234.6 | 4.97 | 14.30 | 326.8 | 0/ 3 | 0.0 |
| 15/120 | 5.0 | 975 | 3 | NO | - | 1002.4 | 1007.3 | 1098.9 | 1006.5 | 967.0 | 1230.8 | 5.00 | 14.30 | 326.8 | 0/ 3 | 0.0 |

# TABLE V-12

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

MIL-H-83282
DUCT & CLAMP
SPRAY

| | --- TEST -- CONDITIONS | | | | | | THERMOCOUPLES | | | | | | | | --- OVERALL --- | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RUN/PT. | VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | LITES / ATTEMPT | M.I.T. DELTA |
| 15/121 | 7.0 | 1150 | 5 | YES | 5.6 | 1195.4 | 1196.7 | 1260.8 | 1210.9 | 1153.0 | 1471.5 | 6.99 | 14.30 | 327.1 | 2/ 3 | 100.0 |
| 15/122 | 7.0 | 1100 | 5 | YES | 5.6 | 1142.8 | 1145.5 | 1217.6 | 1160.5 | 1103.0 | 1414.5 | 6.99 | 14.30 | 326.8 | 1/ 1 | 50.0 |
| 15/123 | 7.0 | 1050 | 5 | NO | - | 1102.1 | 1107.5 | 1180.3 | 1038.8 | 1062.0 | 1363.7 | 6.99 | 14.29 | 326.3 | 0/ 3 | 0.0 |
| 15/124 | 7.0 | 1050 | 5 | NO | - | 1098.0 | 1099.7 | 1180.8 | 1111.1 | 1058.0 | 1361.4 | 6.98 | 14.29 | 326.6 | 0/ 3 | 0.0 |
| 15/125 | 7.0 | 1075 | 0 | NO | - | 1104.2 | 1106.5 | 1189.5 | 1107.0 | 1065.0 | 1366.0 | 6.99 | 14.29 | 326.6 | 0/ 0 | 25.0 |
| 15/126 | 7.0 | 1050 | 3 | NO | - | 1099.0 | 1101.2 | 1189.2 | 1108.4 | 1057.0 | 1361.7 | 6.98 | 14.29 | 326.5 | 0/ 3 | 0.0 |
| 15/127 | 7.0 | 1150 | 3 | NO | - | 1199.5 | 1200.5 | 1258.7 | 1215.6 | 1157.0 | 1477.7 | 6.97 | 14.30 | 327.1 | 2/ 3 | 100.0 |
| 15/128 | 7.0 | 1150 | 5 | YES | 5.3 | 1198.5 | 1200.0 | 1266.0 | 1210.8 | 1157.0 | 1483.7 | 7.04 | 14.29 | 326.7 | 2/ 3 | 100.0 |
| 15/131 | 0.0 | 1225 | 3 | YES | 99.9 | 1245.1 | 1240.3 | 1248.1 | 1248.0 | 1227.0 | 1452.6 | 0.00 | 14.28 | 326.1 | 1/ 1 | 375.0 |
| 15/132 | 0.0 | 975 | 3 | NO | - | 997.3 | 992.2 | 1029.1 | 987.5 | 986.0 | 1161.9 | .14 | 14.28 | 326.3 | 0/ 1 | 125.0 |
| 15/135 | 0.0 | 1025 | 3 | YES | 99.9 | 1040.6 | 1038.1 | 1066.4 | 1047.9 | 1030.0 | 1218.9 | .23 | 8.71 | 107.4 | 1/ 1 | 175.0 |
| 15/136 | 0.0 | 1150 | 3 | NO | - | 991.7 | 989.7 | 1008.5 | 991.0 | 1147.0 | 1161.5 | 0.00 | 8.67 | 106.3 | 0/ 1 | 300.0 |
| 15/137 | 0.0 | 1000 | 3 | YES | 99.9 | 1001.4 | 1000.2 | 1028.9 | 996.6 | 991.0 | 1172.6 | 0.00 | 8.66 | 105.8 | 1/ 1 | 150.0 |
| 15/138 | 0.0 | 950 | 3 | YES | 99.9 | 943.9 | 943.0 | 971.6 | 946.7 | 938.0 | 1104.0 | .14 | 8.64 | 105.3 | 1/ 1 | 100.0 |
| 15/139 | 0.0 | 900 | 3 | NO | - | 897.9 | 895.5 | 931.2 | 896.3 | 890.0 | 1050.4 | .10 | 8.61 | 104.4 | 1/ 2 | 50.0 |
| 15/140 | 0.0 | 900 | 3 | YES | 99.9 | 896.3 | 894.6 | 935.4 | 887.4 | 888.0 | 1048.5 | 0.00 | 8.59 | 104.0 | 1/ 2 | 50.0 |
| 15/141 | 0.0 | 825 | 3 | NO | - | 835.1 | 833.6 | 866.7 | 834.4 | 830.0 | 974.3 | 0.00 | 8.57 | 103.4 | 0/ 1 | -25.0 |
| 15/142 | 0.0 | 850 | 3 | NO | - | 851.5 | 851.6 | 895.0 | 852.2 | 846.0 | 991.0 | 0.00 | 8.55 | 102.9 | 0/ 3 | 0.0 |
| 15/143 | 0.0 | 850 | 3 | NO | - | 849.3 | 846.3 | 890.8 | 848.7 | 843.0 | 984.4 | .10 | 8.54 | 102.6 | 0/ 3 | 0.0 |
| 15/144 | 0.0 | 850 | 3 | NO | - | 850.7 | 848.6 | 894.4 | 845.3 | 845.0 | 987.9 | .22 | 13.21 | 276.5 | 0/ 3 | 0.0 |

# TABLE V-13

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

MIL-H-83282
BARE DUCT
DRIP

| RUN/PT. | --- TEST -- CONDITIONS VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | THERMOCOUPLES T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | --- OVERALL --- LITES / ATTEMPT | M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8/ 1 | 2.0 | 900 | 10 | NO | - | 903.6 | 915.5 | 970.6 | 918.1 | 895.5 | 982.0 | 1.95 | .28 | 90.0 | 0/ 1 | -200.0 |
| 8/ 2 | 2.0 | 1275 | 10 | NO | - | 1283.3 | 1296.1 | 1343.2 | 1291.7 | 1263.2 | 1445.2 | 2.00 | .28 | 90.0 | 1/ 2 | 175.0 |
| 8/ 3 | 2.0 | 1275 | 10 | YES | 4.6 | 1295.2 | 1320.7 | 1351.7 | 1301.2 | 1277.6 | 1461.6 | 1.92 | .28 | 90.0 | 1/ 2 | 175.0 |
| 8/ 4 | 2.0 | 1250 | 10 | YES | 99.9 | 1268.0 | 1280.7 | 1319.7 | 1269.4 | 1243.1 | 1423.0 | 2.08 | .28 | 90.0 | 4/ 4 | 150.0 |
| 8/ 5 | 2.0 | 1250 | 10 | YES | 10.1 | 1278.0 | 1288.5 | 1330.5 | 1276.9 | 1254.5 | 1434.1 | 2.07 | .85 | 117.0 | 4/ 4 | 150.0 |
| 8/ 6 | 2.0 | 1100 | 10 | NO | - | 1106.3 | 1125.9 | 1160.8 | 1116.7 | 1090.1 | 1240.5 | 1.99 | .85 | 117.0 | 0/ 5 | 0.0 |
| 8/ 7 | 0.0 | 1175 | 10 | NO | - | 1183.4 | 1125.9 | 1219.1 | 1121.1 | 1179.3 | 1333.2 | 0.00 | .85 | 117.0 | 0/ 1 | 75.0 |
| 8/ 8 | 2.0 | 1175 | 10 | YES | 11.0 | 1176.3 | 1177.3 | 1224.5 | 1165.1 | 1167.3 | 1373.2 | 1.87 | .85 | 117.0 | 3/ 5 | 75.0 |
| 8/ 9 | 2.0 | 1175 | 10 | YES | 10.5 | 1178.4 | 1181.2 | 1236.0 | 1172.7 | 1168.9 | 1372.6 | 2.03 | .85 | 117.0 | 3/ 5 | 75.0 |
| 8/ 10 | 4.0 | 1175 | 10 | YES | 15.0 | 1176.5 | 1177.5 | 1236.6 | 1173.6 | 1166.7 | 1395.9 | 3.97 | .85 | 117.0 | 2/ 5 | 25.0 |
| 8/ 11 | 6.0 | 1150 | 10 | NO | - | 1170.6 | 1172.7 | 1237.1 | 1169.3 | 1159.2 | 1417.6 | 5.95 | .85 | 117.0 | 0/ 2 | -50.0 |
| 8/ 12 | 6.0 | 1150 | 10 | NO | - | 1164.2 | 1172.6 | 1234.3 | 1169.2 | 1161.7 | 1397.5 | 6.02 | .85 | 117.0 | 0/ 2 | -50.0 |
| 8/ 13 | 8.0 | 1150 | 10 | NO | - | 1166.7 | 1170.3 | 1238.3 | 1169.1 | 1159.7 | 1420.3 | 8.04 | .85 | 117.0 | 0/ 1 | -175.0 |
| 8/ 14 | 2.0 | 1175 | 10 | YES | 12.0 | 1166.7 | 1167.2 | 1218.3 | 1154.3 | 1162.8 | 1350.5 | 1.95 | .85 | 117.0 | 3/ 5 | 75.0 |
| 8/ 15 | 2.0 | 1125 | 10 | YES | 10.5 | 1143.7 | 1151.9 | 1194.2 | 1143.9 | 1132.2 | 1322.4 | 1.98 | .85 | 117.0 | 3/ 5 | 25.0 |
| 8/ 16 | 2.0 | 1125 | 10 | NO | - | 1134.9 | 1130.8 | 1185.8 | 1121.3 | 1124.4 | 1315.0 | 2.02 | .85 | 117.0 | 3/ 5 | 25.0 |
| 8/ 17 | 2.0 | 1100 | 10 | NO | - | 1120.2 | 1118.4 | 1174.1 | 1115.1 | 1112.0 | 1296.5 | 1.98 | .85 | 117.0 | 0/ 5 | 0.0 |
| 8/ 18 | 4.0 | 1150 | 10 | NO | - | 1155.1 | 1163.9 | 1220.4 | 1158.5 | 1145.9 | 1361.1 | 4.00 | .85 | 117.0 | 0/ 4 | 0.0 |
| 8/ 19 | 4.0 | 1175 | 10 | NO | - | 1174.5 | 1178.1 | 1240.7 | 1175.4 | 1170.4 | 1401.4 | 4.00 | .85 | 117.0 | 2/ 5 | 25.0 |
| 8/ 20 | 4.0 | 1175 | 10 | NO | - | 1192.0 | 1207.9 | 1258.1 | 1200.0 | 1187.3 | 1416.3 | 4.08 | .85 | 117.0 | 2/ 5 | 25.0 |
| 8/ 21 | 4.0 | 1200 | 10 | NO | - | 1201.7 | 1204.1 | 1268.6 | 1200.4 | 1193.3 | 1437.2 | 4.01 | .85 | 117.0 | 1/ 2 | 50.0 |
| 8/ 22 | 4.0 | 1250 | 10 | NO | - | 1257.8 | 1266.2 | 1319.3 | 1255.4 | 1248.2 | 1505.2 | 4.02 | .85 | 117.0 | 1/ 2 | 100.0 |
| 8/ 23 | 2.0 | 1250 | 10 | YES | 10.5 | 1249.9 | 1247.1 | 1304.3 | 1242.6 | 1240.6 | 1465.5 | 1.95 | .85 | 117.0 | 4/ 4 | 150.0 |
| 8/ 24 | 2.0 | 1200 | 10 | YES | 10.5 | 1210.0 | 1208.5 | 1266.8 | 1203.6 | 1204.9 | 1414.0 | 1.97 | .85 | 117.0 | 4/ 4 | 100.0 |
| 8/ 25 | 2.0 | 1125 | 10 | YES | 10.5 | 1142.7 | 1139.9 | 1200.5 | 1141.7 | 1135.2 | 1330.8 | 2.02 | .85 | 117.0 | 3/ 5 | 25.0 |
| 8/ 26 | 2.0 | 1125 | 10 | NO | - | 1133.1 | 1132.3 | 1189.0 | 1128.2 | 1124.9 | 1319.5 | 2.07 | .85 | 117.0 | 3/ 5 | 25.0 |
| 8/ 27 | 1.0 | 1125 | 10 | YES | 10.5 | 1119.8 | 1101.3 | 1157.7 | 1102.4 | 1115.0 | 1282.2 | 1.15 | .85 | 117.0 | 1/ 1 | 150.0 |
| 8/ 28 | 1.0 | 1100 | 10 | YES | 11.0 | 1096.2 | 1079.2 | 1133.9 | 1077.6 | 1089.0 | 1243.2 | 1.05 | .85 | 117.0 | 2/ 2 | 125.0 |
| 8/ 29 | 1.0 | 1075 | 10 | NO | - | 1081.8 | 1064.4 | 1120.4 | 1060.0 | 1077.0 | 1227.3 | 1.04 | .85 | 117.0 | 2/ 3 | 100.0 |
| 8/ 30 | 1.0 | 1075 | 10 | YES | 12.0 | 1076.4 | 1060.7 | 1116.4 | 1060.1 | 1070.0 | 1224.9 | 1.04 | .85 | 117.0 | 2/ 3 | 100.0 |
| 8/ 31 | 1.0 | 1075 | 10 | YES | 11.0 | 1069.3 | 1061.4 | 1115.7 | 1057.1 | 1073.2 | 1221.1 | 1.07 | .85 | 117.0 | 2/ 3 | 100.0 |
| 8/ 32 | 1.0 | 1050 | 10 | NO | - | 1050.9 | 1035.9 | 1090.3 | 1033.7 | 1045.7 | 1182.8 | 1.08 | .85 | 117.0 | 1/ 2 | 75.0 |
| 8/ 33 | 1.0 | 1025 | 10 | YES | 99.9 | 1044.8 | 1025.2 | 1078.9 | 1021.7 | 1036.3 | 1184.5 | 1.04 | .85 | 117.0 | 1/ 1 | 50.0 |
| 8/ 34 | 1.0 | 1000 | 10 | YES | 99.9 | 995.4 | 982.2 | 1032.3 | 980.7 | 994.5 | 1126.5 | .97 | .85 | 117.0 | 2/ 6 | 25.0 |
| 8/ 35 | 1.0 | 1000 | 10 | YES | 99.9 | 993.2 | 985.4 | 1029.5 | 979.2 | 989.7 | 1125.0 | 1.08 | .85 | 117.0 | 2/ 6 | 25.0 |
| 8/ 36 | 1.0 | 950 | 0 | NO | - | 940.9 | 923.7 | 976.0 | 916.0 | 937.7 | 1067.3 | 1.03 | .85 | 117.0 | 0/ 1 | -25.0 |
| 8/ 37 | 1.0 | 975 | 10 | NO | - | 965.5 | 950.5 | 1004.3 | 941.4 | 962.8 | 1064.4 | 1.01 | .85 | 117.0 | 0/ 4 | 0.0 |
| 8/ 38 | 1.0 | 950 | 10 | NO | - | 947.0 | 937.4 | 982.1 | 926.7 | 943.4 | 1065.7 | 1.03 | .85 | 117.0 | 0/ 1 | -25.0 |
| 8/ 39 | 0.0 | 1300 | 10 | YES | 11.5 | 1309.3 | 1248.8 | 1339.4 | 1236.6 | 1297.4 | 1478.8 | 0.00 | .85 | 117.0 | 2/ 2 | 200.0 |
| 8/ 40 | 0.0 | 1250 | 10 | YES | 10.5 | 1251.1 | 1191.3 | 1284.6 | 1186.6 | 1246.3 | 1413.9 | 0.00 | .85 | 117.0 | 2/ 2 | 150.0 |

# TABLE V-13



F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

MIL-H-83282
BARE DUCT
DRIP

| RUN/PT. | --- TEST -- CONDITIONS VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | ---- THERMOCOUPLES ---- T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | --- OVERALL --- LITES / ATTEMPT | M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8/ 41 | 0.0 | 1200 | 10 | NO | - | 1208.3 | 1146.2 | 1239.8 | 1138.1 | 1191.9 | 1355.6 | 0.00 | .85 | 117.0 | 1/ 2 | 100.0 |
| 12/ 91 | 2.0 | 1250 | 10 | YES | 11.1 | 1267.0 | 1229.9 | 1271.0 | 73.3 | 1247.3 | 1453.7 | 2.00 | .85 | 117.0 | 4/ 4 | 150.0 |
| 12/ 92 | 2.0 | 1200 | 10 | YES | 11.3 | 1211.2 | 1180.1 | 1222.1 | 75.6 | 1203.0 | 1390.3 | 1.96 | .85 | 117.0 | 4/ 4 | 100.0 |
| 12/ 93 | 2.0 | 1175 | 10 | NO | - | 1188.3 | 1155.5 | 1198.3 | 77.3 | 1176.9 | 1355.5 | 2.02 | .85 | 117.0 | 3/ 5 | 75.0 |
| 12/ 94 | 2.0 | 1175 | 10 | NO | - | 1181.9 | 1154.8 | 1200.3 | 73.4 | 1175.5 | 1365.3 | 2.02 | .85 | 117.0 | 3/ 5 | 75.0 |
| 12/ 95 | 2.0 | 1050 | 0 | YES | 24.2 | 1063.9 | 1033.0 | 1072.3 | 72.6 | 1053.4 | 1212.0 | 1.99 | .85 | 117.0 | 0/ 1 | -50.0 |
| 12/ 96 | 2.0 | 1050 | 0 | YES | 26.1 | 1056.2 | 1029.6 | 1082.5 | 74.3 | 1048.7 | 1218.7 | 2.02 | .85 | 117.0 | 0/ 1 | -50.0 |
| 12/ 97 | 2.0 | 1025 | 0 | YES | 25.0 | 1040.4 | 1006.3 | 1055.8 | 73.7 | 1029.4 | 1191.7 | 1.93 | .85 | 117.0 | 0/ 0 | -75.0 |
| 12/ 98 | 2.0 | 1000 | 0 | YES | 32.1 | 1007.7 | 983.6 | 1026.4 | 75.5 | 998.4 | 1154.5 | 1.92 | .85 | 117.0 | 0/ 0 | -100.0 |
| 12/ 99 | 2.0 | 975 | 10 | NO | - | 988.2 | 954.1 | 1007.0 | 75.8 | 974.5 | 1129.3 | 1.98 | .85 | 117.0 | 0/ 1 | -125.0 |
| 12/158 | 2.0 | 1200 | 10 | YES | 10.6 | 1219.9 | 1257.0 | 1290.6 | 71.3 | 1197.0 | 1457.7 | 1.93 | .85 | 117.0 | 4/ 4 | 100.0 |
| 12/159 | 2.0 | 1050 | 10 | NO | - | 1066.2 | 1097.6 | 1136.1 | 71.1 | 1049.4 | 1259.9 | 1.96 | .85 | 117.0 | 0/ 1 | -50.0 |
| 12/160 | 2.0 | 1200 | 10 | YES | 10.8 | 1224.9 | 1258.6 | 1295.7 | 74.7 | 1200.6 | 1463.7 | 2.02 | .85 | 117.0 | 4/ 4 | 100.0 |
| 12/161 | 2.0 | 1150 | 10 | YES | 10.9 | 1173.1 | 1206.9 | 1243.2 | 76.3 | 1151.4 | 1390.2 | 2.01 | .85 | 117.0 | 1/ 1 | 50.0 |
| 12/162 | 2.0 | 1125 | 10 | YES | 10.8 | 1148.9 | 1177.0 | 1214.6 | 72.4 | 1124.1 | 1366.9 | 1.99 | .85 | 117.0 | 3/ 5 | 25.0 |
| 12/163 | 2.0 | 1100 | 10 | NO | - | 1116.4 | 1161.5 | 1197.1 | 71.6 | 1094.3 | 1344.3 | 1.96 | .85 | 117.0 | 0/ 5 | 0.0 |
| 12/164 | 2.0 | 1100 | 10 | NO | - | 1116.8 | 1151.1 | 1202.9 | 74.0 | 1100.3 | 1355.9 | 1.98 | .85 | 117.0 | 0/ 5 | 0.0 |
| 12/165 | 2.0 | 1100 | 10 | NO | - | 1123.5 | 1157.5 | 1206.7 | 73.4 | 1101.8 | 1350.8 | 1.98 | .85 | 117.0 | 0/ 5 | 0.0 |
| 12/166 | 4.0 | 1250 | 10 | YES | 10.6 | 1277.2 | 1324.1 | 1368.6 | 78.2 | 1253.9 | 1565.7 | 4.05 | .85 | 117.0 | 1/ 2 | 100.0 |
| 12/167 | 4.0 | 1200 | 10 | YES | 11.3 | 1228.4 | 1269.8 | 1315.2 | 73.6 | 1203.6 | 1503.4 | 4.10 | .85 | 117.0 | 1/ 2 | 50.0 |
| 12/168 | 4.0 | 1175 | 10 | NO | - | 1202.2 | 1233.7 | 1290.7 | 74.3 | 1172.9 | 1471.7 | 4.00 | .85 | 117.0 | 2/ 5 | 25.0 |
| 12/169 | 4.0 | 1175 | 10 | YES | 10.8 | 1197.7 | 1238.6 | 1296.9 | 74.3 | 1175.0 | 1473.4 | 3.97 | .85 | 117.0 | 2/ 5 | 25.0 |
| 12/170 | 4.0 | 1150 | 10 | NO | - | 1177.1 | 1212.8 | 1269.5 | 75.5 | 1150.5 | 1445.8 | 3.92 | .85 | 117.0 | 0/ 4 | 0.0 |
| 12/171 | 4.0 | 1150 | 10 | NO | - | 1178.7 | 1220.2 | 1279.9 | 77.1 | 1150.9 | 1450.1 | 3.97 | .85 | 117.0 | 0/ 4 | 0.0 |
| 12/172 | 4.0 | 1150 | 10 | NO | - | 1176.2 | 1214.2 | 1279.6 | 76.9 | 1151.9 | 1452.4 | 3.95 | .85 | 117.0 | 0/ 4 | 0.0 |
| 12/173 | 6.0 | 1300 | 10 | YES | 11.0 | 1331.8 | 1374.9 | 1430.0 | 71.3 | 1303.5 | 1664.1 | 6.01 | .85 | 117.0 | 1/ 1 | 100.0 |
| 12/174 | 6.0 | 1250 | 10 | YES | 10.9 | 1275.2 | 1321.0 | 1369.4 | 73.2 | 1244.2 | 1587.4 | 6.03 | .85 | 117.0 | 1/ 1 | 50.0 |
| 12/175 | 6.0 | 1225 | 10 | YES | 10.8 | 1253.9 | 1293.7 | 1349.6 | 73.5 | 1224.9 | 1559.8 | 6.14 | .85 | 117.0 | 1/ 1 | 25.0 |
| 12/176 | 6.0 | 1200 | 10 | NO | - | 1235.8 | 1273.9 | 1330.9 | 75.5 | 1202.4 | 1531.2 | 6.02 | .85 | 117.0 | 0/ 3 | 0.0 |
| 12/177 | 6.0 | 1200 | 10 | NO | - | 1227.6 | 1267.5 | 1322.3 | 76.2 | 1203.1 | 1529.1 | 6.09 | .85 | 117.0 | 0/ 3 | 0.0 |
| 12/178 | 6.0 | 1200 | 10 | NO | - | 1224.6 | 1272.2 | 1325.5 | 73.4 | 1201.0 | 1533.4 | 6.00 | .85 | 117.0 | 0/ 3 | 0.0 |
| 12/179 | 8.0 | 1350 | 10 | YES | 99.9 | 1379.5 | 1420.5 | 1474.0 | 75.0 | 1347.3 | 1726.9 | 8.00 | .85 | 117.0 | 3/ 4 | 25.0 |
| 12/180 | 8.0 | 1350 | 10 | NO | - | 1374.7 | 1413.3 | 1469.6 | 73.8 | 1342.4 | 1724.5 | 8.16 | .85 | 117.0 | 3/ 4 | 25.0 |
| 12/181 | 8.0 | 1350 | 10 | YES | 99.9 | 1389.0 | 1424.1 | 1480.4 | 75.5 | 1347.5 | 1731.6 | 8.02 | .85 | 117.0 | 3/ 4 | 25.0 |
| 12/182 | 8.0 | 1350 | 10 | YES | 99.9 | 1384.2 | 1432.5 | 1483.6 | 78.5 | 1350.9 | 1733.1 | 8.00 | .85 | 117.0 | 3/ 4 | 25.0 |
| 12/183 | 8.0 | 1325 | 10 | NO | - | 1358.0 | 1394.3 | 1456.4 | 75.2 | 1325.1 | 1703.1 | 8.00 | .85 | 117.0 | 0/ 3 | 0.0 |
| 12/184 | 8.0 | 1325 | 10 | NO | - | 1363.8 | 1403.5 | 1459.6 | 75.7 | 1326.3 | 1710.1 | 8.12 | .85 | 117.0 | 0/ 3 | 0.0 |
| 12/185 | 8.0 | 1325 | 10 | NO | - | 1356.5 | 1401.0 | 1458.5 | 74.0 | 1327.0 | 1708.5 | 8.23 | .85 | 117.0 | 0/ 3 | 0.0 |
| 12/186 | 1.0 | 1100 | 10 | YES | 10.7 | 1125.0 | 1141.2 | 1165.5 | 76.8 | 1102.0 | 1301.9 | 1.08 | .85 | 117.0 | 2/ 2 | 125.0 |
| 12/187 | 1.0 | 1050 | 10 | YES | 11.4 | 1068.9 | 1083.2 | 1115.4 | 73.8 | 1049.9 | 1247.5 | 1.03 | .85 | 117.0 | 1/ 2 | 75.0 |

# TABLE V-13

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

MIL-H-83282
BARE DUCT
DRIP

| RUN/PT. | TEST CONDITIONS VEL | TEST CONDITIONS TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | THERMOCOUPLES T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | OVERALL LITES / ATTEMPT | OVERALL M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/188 | 1.0 | 1000 | 10 | NO | - | 1020.2 | 1033.8 | 1070.9 | 73.2 | 1003.2 | 1194.7 | 1.05 | .85 | 117.0 | 2/ 6 | 25.0 |
| 12/189 | 1.0 | 1000 | 10 | NO | - | 1015.6 | 1043.6 | 1076.6 | 74.0 | 1004.0 | 1201.0 | 1.05 | .85 | 117.0 | 2/ 6 | 25.0 |
| 12/190 | 1.0 | 1000 | 10 | NO | - | 1021.5 | 1034.7 | 1077.6 | 74.1 | 996.8 | 1196.6 | 1.01 | .85 | 117.0 | 2/ 6 | 25.0 |
| 12/191 | 1.0 | 1000 | 10 | NO | - | 1026.2 | 1038.1 | 1077.0 | 75.6 | 1003.8 | 1201.0 | 1.03 | .85 | 117.0 | 2/ 6 | 25.0 |
| 12/192 | 1.0 | 975 | 10 | NO | - | 996.0 | 1003.8 | 1054.5 | 77.9 | 977.7 | 1174.8 | 1.03 | .85 | 117.0 | 0/ 4 | 0.0 |
| 12/193 | 1.0 | 975 | 10 | NO | - | 998.5 | 1014.7 | 1056.2 | 77.8 | 974.2 | 1176.7 | .99 | .85 | 117.0 | 0/ 4 | 0.0 |
| 12/194 | 1.0 | 975 | 10 | NO | - | 1000.8 | 1022.6 | 1066.3 | 74.2 | 980.5 | 1189.7 | 1.05 | .85 | 117.0 | 0/ 4 | 0.0 |
| 12/195 | 1.0 | 975 | 0 | YES | 27.0 | 991.3 | 1000.7 | 1049.5 | 73.5 | 975.3 | 1166.5 | .97 | .85 | 117.0 | 0/ 4 | 0.0 |
| 12/196 | 0.0 | 1300 | 10 | YES | 11.1 | 1324.1 | 1287.8 | 1366.3 | 73.1 | 1299.1 | 1518.1 | 0.00 | .85 | 117.0 | 2/ 2 | 200.0 |
| 12/197 | 0.0 | 1250 | 10 | YES | 11.0 | 1277.6 | 1236.5 | 1315.2 | 77.3 | 1248.1 | 1452.6 | 0.00 | .85 | 117.0 | 2/ 2 | 150.0 |
| 12/198 | 0.0 | 1200 | 10 | YES | 10.9 | 1221.8 | 1196.8 | 1271.3 | 73.7 | 1200.1 | 1398.9 | 0.00 | .85 | 117.0 | 1/ 2 | 100.0 |
| 12/199 | 0.0 | 1150 | 10 | NO | - | 1170.9 | 1143.9 | 1215.2 | 75.9 | 1149.5 | 1333.5 | 0.00 | .85 | 117.0 | 1/ 2 | 50.0 |
| 12/200 | 0.0 | 1150 | 10 | YES | 99.9 | 1169.5 | 1142.7 | 1221.8 | 70.6 | 1151.6 | 1329.3 | 0.00 | .85 | 117.0 | 1/ 2 | 50.0 |
| 12/201 | 0.0 | 1100 | 10 | NO | - | 1115.0 | 1096.1 | 1172.1 | 73.4 | 1095.5 | 1274.9 | 0.00 | .85 | 117.0 | 0/ 3 | 0.0 |
| 12/202 | 0.0 | 1100 | 10 | NO | - | 1118.8 | 1091.7 | 1172.0 | 73.6 | 1099.1 | 1264.0 | 0.00 | .85 | 117.0 | 0/ 3 | 0.0 |
| 12/203 | 0.0 | 1100 | 10 | NO | - | 1117.8 | 1092.1 | 1179.6 | 72.9 | 1103.6 | 1285.1 | 0.00 | .85 | 117.0 | 0/ 3 | 0.0 |

# TABLE V-14



F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

MIL-H-83282
DUCT & CLAMP
DRIP

| RUN/PT. | --- TEST -- CONDITIONS VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | THERMOCOUPLES T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | --- OVERALL --- LITES / ATTEMPT | M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16/ 1 | 2.0 | 1150 | 10 | YES | .4 | 1194.4 | 1194.5 | 1207.7 | 1201.9 | 1155.0 | 1422.0 | 2.03 | .85 | 117.0 | 1/ 1 | 425.0 |
| 16/ 2 | 2.0 | 1050 | 10 | YES | .8 | 1094.3 | 1096.0 | 1111.3 | 1100.3 | 1053.0 | 1299.0 | 1.97 | .85 | 117.0 | 1/ 1 | 325.0 |
| 16/ 3 | 2.0 | 950 | 10 | YES | .8 | 997.5 | 1000.0 | 1025.8 | 1000.1 | 961.0 | 1184.9 | 2.02 | .85 | 117.0 | 2/ 2 | 225.0 |
| 16/ 4 | 2.0 | 875 | 10 | YES | 1.5 | 836.4 | 900.7 | 934.9 | 899.0 | 866.0 | 1053.4 | 2.04 | .85 | 117.0 | 1/ 1 | 150.0 |
| 16/ 5 | 2.0 | 775 | 10 | YES | 2.7 | 799.8 | 806.0 | 837.4 | 807.8 | 770.0 | 955.9 | 2.00 | .85 | 117.0 | 1/ 1 | 50.0 |
| 16/ 6 | 2.0 | 675 | 10 | NO | - | 696.3 | 703.8 | 740.1 | 704.5 | 672.0 | 833.6 | 2.00 | .85 | 117.0 | 0/ 3 | -50.0 |
| 16/ 7 | 2.0 | 675 | 10 | NO | - | 697.5 | 706.0 | 740.2 | 708.3 | 670.0 | 831.2 | 2.04 | .85 | 117.0 | 0/ 3 | -50.0 |
| 16/ 8 | 2.0 | 675 | 10 | NO | - | 700.5 | 707.0 | 752.4 | 708.3 | 676.0 | 836.7 | 2.01 | .85 | 117.0 | 0/ 3 | -50.0 |
| 16/ 9 | 2.0 | 950 | 10 | YES | 1.0 | 996.0 | 1002.3 | 1046.5 | 1006.5 | 959.0 | 1194.4 | 1.99 | .85 | 117.0 | 2/ 2 | 225.0 |
| 16/ 10 | 2.0 | 725 | 10 | NO | - | 745.1 | 750.5 | 785.0 | 752.9 | 719.0 | 894.5 | 2.01 | .85 | 117.0 | 0/ 6 | 0.0 |
| 16/ 11 | 2.0 | 725 | 10 | NO | - | 749.1 | 755.1 | 792.1 | 756.2 | 724.0 | 893.2 | 1.96 | .85 | 117.0 | 0/ 6 | 0.0 |
| 16/ 12 | 2.0 | 725 | 10 | NO | - | 747.4 | 753.1 | 796.8 | 749.9 | 722.0 | 891.2 | 1.96 | .85 | 117.0 | 0/ 6 | 0.0 |
| 16/ 13 | 2.0 | 975 | 10 | YES | .7 | 1002.6 | 1003.6 | 1033.5 | 1007.2 | 964.0 | 1192.6 | 2.02 | 1.69 | 140.0 | 1/ 1 | 250.0 |
| 16/ 14 | 2.0 | 725 | 10 | NO | - | 750.2 | 755.6 | 786.5 | 754.2 | 723.0 | 893.9 | 2.00 | 1.69 | 140.0 | 0/ 6 | 0.0 |
| 16/ 15 | 2.0 | 725 | 10 | NO | - | 751.1 | 757.1 | 798.4 | 764.4 | 723.0 | 891.9 | 2.00 | 1.69 | 140.0 | 0/ 6 | 0.0 |
| 16/ 16 | 2.0 | 725 | 10 | NO | - | 752.3 | 758.5 | 810.9 | 766.8 | 726.0 | 896.4 | 2.02 | 1.69 | 140.0 | 0/ 6 | 0.0 |
| 16/ 17 | 4.0 | 1150 | 10 | YES | .6 | 1199.5 | 1199.0 | 1256.7 | 1208.1 | 1153.0 | 1455.8 | 3.97 | .85 | 117.0 | 1/ 1 | 325.0 |
| 16/ 18 | 4.0 | 975 | 10 | YES | 1.8 | 1000.9 | 1003.2 | 1051.0 | 1015.8 | 963.0 | 1219.9 | 4.07 | .85 | 117.0 | 2/ 3 | 150.0 |
| 16/ 19 | 4.0 | 925 | 10 | YES | 1.3 | 954.6 | 957.9 | 1011.3 | 966.0 | 918.0 | 1162.7 | 4.01 | .85 | 117.0 | 1/ 1 | 100.0 |
| 16/ 20 | 4.0 | 875 | 10 | NO | - | 899.1 | 902.7 | 954.5 | 912.0 | 865.0 | 1100.2 | 3.98 | .85 | 117.0 | 1/ 2 | 50.0 |
| 16/ 21 | 4.0 | 875 | 10 | YES | 1.7 | 898.8 | 901.0 | 968.1 | 913.4 | 866.0 | 1100.3 | 4.01 | .85 | 117.0 | 1/ 2 | 50.0 |
| 16/ 22 | 4.0 | 825 | 10 | NO | - | 852.2 | 855.9 | 914.4 | 869.1 | 821.0 | 1039.6 | 4.04 | .85 | 117.0 | 0/ 6 | 0.0 |
| 16/ 23 | 4.0 | 825 | 10 | NO | - | 855.4 | 860.1 | 927.0 | 868.8 | 825.0 | 1046.5 | 4.01 | .85 | 117.0 | 0/ 6 | 0.0 |
| 16/ 24 | 4.0 | 825 | 10 | NO | - | 857.3 | 862.8 | 932.7 | 871.1 | 826.0 | 1045.6 | 4.02 | .85 | 117.0 | 0/ 6 | 0.0 |
| 16/ 25 | 4.0 | 975 | 10 | NO | - | 1004.0 | 1006.1 | 1073.4 | 1015.8 | 966.0 | 1222.7 | 3.99 | .16 | 80.0 | 2/ 3 | 150.0 |
| 16/ 26 | 4.0 | 975 | 10 | YES | 1.3 | 1006.5 | 1007.4 | 1068.9 | 1018.4 | 968.0 | 1232.0 | 4.08 | 1.69 | 140.0 | 2/ 3 | 150.0 |
| 16/ 27 | 4.0 | 825 | 10 | NO | - | 850.5 | 853.4 | 914.0 | 859.0 | 817.0 | 1046.4 | 3.99 | 1.69 | 140.0 | 0/ 6 | 0.0 |
| 16/ 28 | 4.0 | 825 | 10 | NO | - | 855.2 | 860.3 | 931.0 | 865.0 | 823.0 | 1046.9 | 3.96 | 1.69 | 140.0 | 0/ 6 | 0.0 |
| 16/ 29 | 4.0 | 825 | 10 | NO | - | 846.1 | 851.6 | 929.6 | 861.1 | 813.0 | 1038.5 | 3.93 | 1.69 | 140.0 | 0/ 6 | 0.0 |
| 16/ 30 | 6.0 | 1150 | 10 | YES | .8 | 1200.9 | 1201.5 | 1255.8 | 1217.8 | 1156.0 | 1479.6 | 6.13 | .85 | 117.0 | 2/ 2 | 175.0 |
| 16/ 31 | 6.0 | 1050 | 10 | YES | 1.7 | 1102.4 | 1104.7 | 1161.0 | 1120.0 | 1061.0 | 1364.9 | 6.07 | .85 | 117.0 | 1/ 1 | 75.0 |
| 16/ 32 | 6.0 | 1025 | 10 | YES | 10.7 | 1052.0 | 1054.3 | 1110.3 | 1067.6 | 1013.0 | 1303.4 | 5.99 | .85 | 117.0 | 1/ 1 | 50.0 |
| 16/ 33 | 6.0 | 975 | 10 | NO | - | 1004.6 | 1006.2 | 1066.4 | 1022.5 | 965.0 | 1249.6 | 6.08 | .85 | 117.0 | 0/ 2 | 0.0 |
| 16/ 34 | 6.0 | 950 | 10 | NO | - | 1000.5 | 1002.4 | 1065.0 | 1016.2 | 961.0 | 1238.2 | 5.98 | .85 | 117.0 | 0/ 1 | -25.0 |
| 16/ 35 | 6.0 | 975 | 10 | NO | - | 1004.3 | 1006.4 | 1078.5 | 1016.8 | 967.0 | 1243.0 | 6.03 | .85 | 117.0 | 0/ 2 | 0.0 |
| 16/ 36 | 6.0 | 1250 | 10 | YES | .5 | 1301.0 | 1299.0 | 1352.0 | 1313.3 | 1253.0 | 1593.7 | 6.01 | .85 | 117.0 | 1/ 1 | 275.0 |
| 16/ 37 | 6.0 | 1150 | 10 | YES | .5 | 1201.8 | 1202.5 | 1247.8 | 1218.4 | 1157.0 | 1479.0 | 6.06 | .85 | 117.0 | 2/ 2 | 175.0 |
| 16/ 38 | 8.0 | 1050 | 10 | YES | 9.9 | 1104.3 | 1105.6 | 1157.9 | 1122.6 | 1061.0 | 1382.9 | 8.04 | .85 | 117.0 | 1/ 1 | 50.0 |
| 16/ 39 | 8.0 | 1000 | 10 | NO | - | 1048.0 | 1051.9 | 1110.6 | 1069.1 | 1009.0 | 1319.2 | 7.98 | .85 | 117.0 | 0/ 5 | 0.0 |
| 16/ 40 | 8.0 | 1025 | 0 | NO | - | 1054.7 | 1055.2 | 1122.0 | 1064.7 | 1014.0 | 1319.9 | 7.92 | .85 | 117.0 | 0/ 0 | 25.0 |

# TABLE V-14

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

MIL-H-83282
DUCT & CLAMP
DRIP

| RUN/PT. | --- TEST -- CONDITIONS VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | THERMOCOUPLES T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | --- OVERALL --- LITES / ATTEMPT | M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16/ 41 | 8.0 | 1000 | 10 | NO | - | 1054.2 | 1054.5 | 1129.5 | 1068.6 | 1012.0 | 1319.7 | 8.03 | .85 | 117.0 | 0/ 5 | 0.0 |
| 16/ 42 | 8.0 | 1150 | 10 | YES | 1.0 | 1205.2 | 1204.9 | 1264.1 | 1226.2 | 1160.0 | 1500.2 | 8.03 | 1.69 | 140.0 | 1/ 1 | 150.0 |
| 16/ 43 | 8.0 | 1000 | 10 | NO | - | 1050.1 | 1051.9 | 1103.2 | 1078.1 | 1010.0 | 1313.7 | 8.03 | 1.69 | 140.0 | 0/ 5 | 0.0 |
| 16/ 44 | 8.0 | 1000 | 10 | NO | - | 1044.6 | 1046.0 | 1116.8 | 1056.9 | 1005.0 | 1316.9 | 7.95 | 1.69 | 140.0 | 0/ 5 | 0.0 |
| 16/ 45 | 8.0 | 1000 | 10 | NO | - | 1048.3 | 1049.6 | 1124.6 | 1063.6 | 1009.0 | 1315.4 | 7.98 | 1.69 | 140.0 | 0/ 5 | 0.0 |
| 16/ 46 | 1.0 | 1200 | 10 | YES | .6 | 1250.4 | 1248.1 | 1248.2 | 1257.2 | 1206.0 | 1470.9 | 1.07 | .85 | 117.0 | 1/ 1 | 475.0 |
| 16/ 47 | 1.0 | 1050 | 10 | YES | .5 | 1098.7 | 1100.3 | 1099.0 | 1102.9 | 1059.0 | 1283.6 | .98 | .85 | 117.0 | 1/ 1 | 325.0 |
| 16/ 48 | 1.0 | 875 | 10 | YES | .9 | 898.6 | 899.6 | 905.2 | 904.3 | 869.0 | 1046.3 | 1.03 | .85 | 117.0 | 1/ 1 | 150.0 |
| 16/ 49 | 1.0 | 825 | 10 | YES | 1.3 | 845.3 | 845.5 | 851.0 | 850.5 | 816.0 | 982.5 | 1.00 | .85 | 117.0 | 1/ 1 | 100.0 |
| 16/ 50 | 1.0 | 775 | 10 | YES | 2.2 | 797.1 | 799.0 | 807.6 | 802.4 | 765.0 | 929.3 | 1.00 | .85 | 117.0 | 1/ 1 | 50.0 |
| 16/ 51 | 1.0 | 725 | 10 | NO | - | 749.3 | 749.4 | 760.9 | 754.4 | 722.0 | 878.5 | .96 | .85 | 117.0 | 0/ 8 | 0.0 |
| 16/ 52 | 1.0 | 725 | 10 | NO | - | 741.9 | 743.3 | 760.3 | 749.0 | 717.0 | 857.0 | 1.01 | .85 | 117.0 | 0/ 8 | 0.0 |
| 16/ 53 | 1.0 | 725 | 10 | NO | - | 749.2 | 754.3 | 772.2 | 750.8 | 726.0 | 872.3 | 1.03 | .85 | 117.0 | 0/ 8 | 0.0 |
| 16/ 54 | 1.0 | 1150 | 10 | YES | 3.7 | 1198.5 | 1196.3 | 1208.0 | 1200.7 | 1155.0 | 1408.8 | 1.07 | .28 | 90.0 | 2/ 2 | 425.0 |
| 16/ 55 | 1.0 | 725 | 10 | NO | - | 750.8 | 752.5 | 767.5 | 753.5 | 724.0 | 872.8 | 1.12 | .28 | 90.0 | 0/ 8 | 0.0 |
| 16/ 56 | 1.0 | 725 | 10 | NO | - | 752.1 | 754.5 | 768.6 | 756.3 | 725.0 | 870.3 | 1.03 | .28 | 90.0 | 0/ 8 | 0.0 |
| 16/ 57 | 1.0 | 700 | 10 | NO | - | 719.3 | 696.3 | 767.2 | 755.2 | 696.0 | 872.4 | 1.07 | .28 | 90.0 | 0/ 1 | -25.0 |
| 16/ 58 | 1.0 | 1150 | 10 | YES | .5 | 1194.4 | 1192.1 | 1206.7 | 1204.6 | 1155.0 | 1406.0 | .93 | 1.69 | 140.0 | 2/ 2 | 425.0 |
| 16/ 59 | 1.0 | 725 | 10 | NO | - | 747.8 | 749.6 | 762.0 | 752.4 | 722.0 | 875.2 | 1.11 | 1.69 | 140.0 | 0/ 8 | 0.0 |
| 16/ 60 | 1.0 | 725 | 10 | NO | - | 746.2 | 750.0 | 765.1 | 757.7 | 723.0 | 871.2 | 1.06 | 1.69 | 140.0 | 0/ 8 | 0.0 |
| 16/ 61 | 1.0 | 725 | 10 | NO | - | 750.6 | 753.7 | 773.9 | 765.9 | 726.0 | 873.7 | 1.00 | 1.69 | 140.0 | 0/ 8 | 0.0 |
| 16/ 62 | 0.0 | 1175 | 10 | YES | .5 | 1200.6 | 1194.8 | 1223.5 | 1209.3 | 1184.0 | 1401.0 | .20 | .85 | 117.0 | 1/ 1 | 325.0 |
| 16/ 63 | 0.0 | 900 | 10 | NO | - | 901.8 | 896.0 | 919.9 | 901.8 | 894.0 | 1041.0 | .17 | .85 | 117.0 | 1/ 3 | 50.0 |
| 16/ 64 | 0.0 | 1000 | 10 | YES | 1.1 | 1001.0 | 997.4 | 1030.8 | 998.2 | 991.0 | 1165.5 | .20 | .85 | 117.0 | 1/ 1 | 150.0 |
| 16/ 65 | 0.0 | 950 | 10 | YES | 1.0 | 952.8 | 946.0 | 975.4 | 950.5 | 940.0 | 1110.4 | 0.00 | .85 | 117.0 | 1/ 1 | 100.0 |
| 16/ 66 | 0.0 | 900 | 10 | NO | - | 905.0 | 900.4 | 928.7 | 902.7 | 897.0 | 1048.7 | 0.00 | .85 | 117.0 | 1/ 3 | 50.0 |
| 16/ 67 | 0.0 | 900 | 10 | YES | 7.6 | 899.2 | 894.6 | 931.3 | 893.7 | 870.0 | 1043.0 | .14 | .85 | 117.0 | 1/ 3 | 50.0 |
| 16/ 68 | 0.0 | 850 | 10 | NO | - | 847.0 | 844.1 | 883.5 | 848.8 | 843.0 | 981.7 | .24 | .85 | 117.0 | 0/ 3 | 0.0 |
| 16/ 69 | 0.0 | 850 | 10 | NO | - | 846.6 | 843.6 | 887.2 | 840.6 | 841.0 | 985.3 | 0.00 | .85 | 117.0 | 0/ 3 | 0.0 |
| 16/ 70 | 0.0 | 850 | 10 | NO | - | 851.1 | 849.6 | 893.4 | 845.5 | 846.0 | 981.8 | 0.00 | .85 | 117.0 | 0/ 3 | 0.0 |

# TABLE V-15



F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

MIL-H-83282
OBSTRUCTIONS
DRIP

| | --- TEST -- CONDITIONS | | INJ. | IGN. | COMB | ------------ | ------------ | THERMOCOUPLES | ------------ | ------------ | ------------ | NAC. | FUEL | FUEL | --- OVERALL --- | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RUN/PT. | VEL | TEMP | TIME | (Y/N) | TIME | T1 | T2 | T3 | T4 | T5 | T6 | VEL. | FLOW | REG. | LITES / ATTEMPT | M.I.T. DELTA |
| 22/ 1 | 4.0 | 1300 | 10 | YES | .6 | 1325.0 | 1324.4 | 1286.6 | 1305.2 | 1298.1 | 1547.4 | 4.03 | .85 | 117.0 | 1/ 1 | 500.0 |
| 22/ 2 | 4.0 | 1100 | 10 | YES | .9 | 1118.3 | 1128.1 | 1083.0 | 1107.4 | 1096.6 | 1298.7 | 3.98 | .85 | 117.0 | 1/ 1 | 300.0 |
| 22/ 3 | 4.0 | 1000 | 10 | YES | 1.3 | 1013.8 | 1025.0 | 981.7 | 1006.3 | 998.7 | 1173.9 | 4.07 | .85 | 117.0 | 1/ 1 | 200.0 |
| 22/ 4 | 4.0 | 950 | 10 | YES | 3.5 | 964.0 | 976.5 | 939.1 | 954.7 | 950.4 | 1117.6 | 3.99 | .85 | 117.0 | 1/ 1 | 150.0 |
| 22/ 5 | 4.0 | 900 | 10 | YES | 4.6 | 906.2 | 921.0 | 883.1 | 899.9 | 896.7 | 1050.5 | 4.00 | .85 | 117.0 | 1/ 1 | 100.0 |
| 22/ 6 | 4.0 | 850 | 10 | NO | - | 855.4 | 871.4 | 834.7 | 850.1 | 847.1 | 992.6 | 3.98 | .85 | 117.0 | 1/ 2 | 50.0 |
| 22/ 7 | 4.0 | 850 | 10 | YES | 4.5 | 855.8 | 867.2 | 840.2 | 849.5 | 849.2 | 996.6 | 3.97 | .85 | 117.0 | 1/ 2 | 50.0 |
| 22/ 8 | 4.0 | 800 | 10 | NO | - | 801.5 | 819.8 | 786.4 | 795.6 | 797.1 | 930.0 | 3.99 | .85 | 117.0 | 0/ 3 | 0.0 |
| 22/ 9 | 4.0 | 800 | 10 | NO | - | 805.1 | 821.5 | 793.8 | 800.8 | 801.5 | 935.2 | 3.98 | .85 | 117.0 | 0/ 3 | 0.0 |
| 22/ 10 | 4.0 | 800 | 10 | NO | - | 802.0 | 819.3 | 794.3 | 797.1 | 797.4 | 932.8 | 3.94 | .85 | 117.0 | 0/ 3 | 0.0 |
| 22/ 11 | 6.0 | 1300 | 10 | YES | .7 | 1327.7 | 1330.9 | 1289.5 | 1302.1 | 1303.4 | 1551.7 | 6.00 | .85 | 117.0 | 1/ 1 | 350.0 |
| 22/ 12 | 6.0 | 1100 | 10 | YES | 1.2 | 1114.7 | 1126.8 | 1075.5 | 1098.4 | 1100.1 | 1301.2 | 5.98 | .85 | 117.0 | 1/ 1 | 150.0 |
| 22/ 13 | 6.0 | 1050 | 10 | YES | 4.1 | 1057.2 | 1069.8 | 1021.8 | 1043.3 | 1046.3 | 1232.1 | 5.95 | .85 | 117.0 | 1/ 1 | 100.0 |
| 22/ 14 | 6.0 | 1000 | 10 | YES | 3.6 | 1007.4 | 1016.4 | 974.4 | 994.3 | 996.3 | 1175.2 | 5.97 | .85 | 117.0 | 1/ 1 | 50.0 |
| 22/ 15 | 6.0 | 950 | 10 | NO | - | 955.5 | 970.7 | 925.5 | 944.8 | 947.8 | 1117.0 | 5.95 | .85 | 117.0 | 0/ 3 | 0.0 |
| 22/ 16 | 6.0 | 950 | 10 | NO | - | 953.2 | 958.7 | 925.9 | 942.3 | 950.2 | 1113.5 | 6.01 | .85 | 117.0 | 0/ 3 | 0.0 |
| 22/ 17 | 6.0 | 950 | 10 | NO | - | 951.8 | 967.7 | 932.0 | 941.0 | 947.5 | 1112.5 | 5.99 | .85 | 117.0 | 0/ 3 | 0.0 |
| 22/ 18 | 8.0 | 1300 | 10 | YES | .6 | 1317.6 | 1318.6 | 1265.6 | 1289.9 | 1295.5 | 1547.3 | 7.96 | .85 | 117.0 | 1/ 1 | 300.0 |
| 22/ 19 | 8.0 | 1100 | 10 | YES | 2.4 | 1100.4 | 1119.6 | 1060.1 | 1091.1 | 1098.1 | 1299.7 | 7.99 | .85 | 117.0 | 1/ 1 | 100.0 |
| 22/ 20 | 8.0 | 1050 | 10 | NO | - | 1056.7 | 1066.6 | 1014.3 | 1040.1 | 1048.5 | 1237.6 | 8.09 | .85 | 117.0 | 1/ 2 | 50.0 |
| 22/ 21 | 8.0 | 1050 | 10 | YES | 8.9 | 1056.3 | 1068.0 | 1017.8 | 1040.8 | 1048.5 | 1240.9 | 8.04 | .85 | 117.0 | 1/ 2 | 50.0 |
| 22/ 22 | 8.0 | 1000 | 10 | NO | - | 1003.7 | 1017.5 | 967.3 | 990.4 | 1001.2 | 1184.0 | 7.93 | .85 | 117.0 | 0/ 3 | 0.0 |
| 22/ 23 | 8.0 | 1000 | 10 | NO | - | 1004.2 | 1022.3 | 975.2 | 991.0 | 1003.6 | 1184.9 | 8.10 | .85 | 117.0 | 0/ 3 | 0.0 |
| 22/ 24 | 8.0 | 1000 | 10 | NO | - | 1006.0 | 1022.0 | 978.6 | 992.7 | 1000.7 | 1136.4 | 7.98 | .85 | 117.0 | 0/ 3 | 0.0 |
| 22/ 25 | 2.0 | 1300 | 10 | YES | .5 | 1337.1 | 1337.1 | 1299.5 | 1320.0 | 1296.4 | 1549.1 | 2.06 | .85 | 117.0 | 1/ 1 | 500.0 |
| 22/ 26 | 2.0 | 1100 | 10 | YES | .7 | 1130.9 | 1137.7 | 1098.8 | 1117.7 | 1097.8 | 1299.5 | 2.02 | .85 | 117.0 | 1/ 1 | 300.0 |
| 22/ 27 | 2.0 | 900 | 10 | NO | - | 922.1 | 931.5 | 898.0 | 915.3 | 899.4 | 1050.1 | 2.00 | .85 | 117.0 | 2/ 3 | 100.0 |
| 22/ 28 | 2.0 | 1000 | 10 | YES | 1.1 | 1027.7 | 1036.0 | 1014.4 | 1019.9 | 1001.4 | 1177.7 | 2.03 | .85 | 117.0 | 2/ 2 | 200.0 |
| 22/ 29 | 2.0 | 900 | 10 | YES | .8 | 921.7 | 931.3 | 902.6 | 918.4 | 900.9 | 1054.1 | 2.04 | .85 | 117.0 | 2/ 3 | 100.0 |
| 22/ 30 | 2.0 | 800 | 10 | NO | - | 816.9 | 826.1 | 790.2 | 812.8 | 806.5 | 934.5 | 2.04 | .85 | 117.0 | 0/ 5 | 0.0 |
| 22/ 31 | 2.0 | 1000 | 10 | YES | 1.3 | 1025.6 | 1035.8 | 1017.1 | 1021.1 | 1003.4 | 1178.8 | 2.02 | .85 | 117.0 | 2/ 2 | 200.0 |
| 22/ 32 | 2.0 | 900 | 10 | YES | 8.8 | 921.0 | 927.4 | 905.4 | 917.8 | 901.3 | 1058.1 | 2.04 | .85 | 117.0 | 2/ 3 | 100.0 |
| 22/ 33 | 2.0 | 850 | 10 | YES | 1.9 | 865.1 | 875.4 | 853.4 | 863.6 | 850.8 | 994.4 | 2.03 | .85 | 117.0 | 2/ 2 | 50.0 |
| 22/ 34 | 2.0 | 800 | 10 | NO | - | 810.0 | 820.0 | 798.5 | 807.7 | 796.1 | 935.2 | 2.03 | .85 | 117.0 | 0/ 5 | 0.0 |
| 22/ 35 | 2.0 | 800 | 10 | NO | - | 811.0 | 819.1 | 799.2 | 809.2 | 799.8 | 926.1 | 2.05 | .85 | 117.0 | 0/ 5 | 0.0 |
| 22/ 36 | 2.0 | 800 | 10 | NO | - | 810.0 | 819.3 | 808.1 | 808.3 | 796.2 | 928.6 | 2.02 | .85 | 117.0 | 0/ 5 | 0.0 |
| 22/ 37 | 2.0 | 850 | 10 | YES | 1.8 | 872.3 | 880.5 | 854.0 | 866.2 | 855.0 | 996.5 | 1.96 | .85 | 117.0 | 2/ 2 | 50.0 |
| 22/ 38 | 2.0 | 800 | 10 | NO | - | 813.9 | 821.0 | 792.1 | 808.4 | 793.3 | 930.4 | 2.02 | .85 | 117.0 | 0/ 5 | 0.0 |
| 22/ 39 | 1.0 | 1000 | 10 | YES | 1.8 | 1027.7 | 1035.6 | 1021.8 | 1014.4 | 1000.7 | 1178.5 | 1.01 | .85 | 117.0 | 2/ 2 | 200.0 |
| 22/ 40 | 1.0 | 900 | 10 | NO | - | 924.4 | 932.1 | 914.6 | 916.6 | 905.0 | 1059.6 | .98 | .85 | 117.0 | 1/ 3 | 100.0 |

# TABLE V-15

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

MIL-H-83282
OBSTRUCTIONS
DRIP

| RUN/PT. | --- TEST -- CONDITIONS VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | THERMOCOUPLES T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | --- OVERALL --- LITES / ATTEMPT | M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 22/ 41 | 1.0 | 1000 | 10 | YES | .8 | 1027.9 | 1035.3 | 1025.1 | 1015.2 | 1001.5 | 1175.4 | 1.00 | .85 | 117.0 | 2/ 2 | 200.0 |
| 22/ 42 | 1.0 | 950 | 10 | YES | 5.3 | 974.8 | 980.7 | 965.3 | 963.7 | 952.2 | 1116.7 | .97 | .85 | 117.0 | 1/ 1 | 150.0 |
| 22/ 43 | 1.0 | 900 | 10 | NO | - | 919.4 | 929.7 | 912.9 | 910.8 | 895.2 | 1053.0 | .94 | .85 | 117.0 | 1/ 3 | 100.0 |
| 22/ 44 | 1.0 | 900 | 10 | YES | .8 | 921.7 | 933.0 | 922.8 | 912.4 | 900.6 | 1052.8 | 1.01 | .85 | 117.0 | 1/ 3 | 100.0 |
| 22/ 45 | 1.0 | 850 | 10 | YES | 1.4 | 872.4 | 881.4 | 868.8 | 863.2 | 854.4 | 997.7 | 1.01 | .85 | 117.0 | 1/ 1 | 50.0 |
| 22/ 46 | 1.0 | 800 | 10 | NO | - | 818.5 | 829.2 | 814.1 | 812.5 | 801.0 | 936.4 | 1.04 | .85 | 117.0 | 0/ 3 | 0.0 |
| 22/ 47 | 1.0 | 800 | 10 | NO | - | 816.2 | 825.9 | 818.1 | 807.5 | 799.1 | 933.8 | 1.00 | .85 | 117.0 | 0/ 3 | 0.0 |
| 22/ 48 | 1.0 | 800 | 10 | NO | - | 818.6 | 830.0 | 827.4 | 810.1 | 802.1 | 938.8 | 1.00 | .85 | 117.0 | 0/ 3 | 0.0 |
| 22/ 49 | 0.0 | 1000 | 10 | YES | .8 | 1016.5 | 1004.0 | 1022.9 | 1008.6 | 997.2 | 1158.9 | .14 | .85 | 117.0 | 1/ 1 | 100.0 |
| 22/ 50 | 0.0 | 950 | 10 | YES | 1.1 | 971.6 | 960.8 | 971.4 | 967.6 | 953.4 | 1105.6 | 0.00 | .85 | 117.0 | 1/ 1 | 50.0 |
| 22/ 51 | 0.0 | 900 | 10 | NO | - | 921.5 | 914.0 | 925.9 | 915.8 | 905.4 | 1046.9 | 0.00 | .85 | 117.0 | 0/ 3 | 0.0 |
| 22/ 52 | 0.0 | 900 | 10 | NO | - | 917.2 | 908.9 | 925.9 | 910.6 | 900.4 | 1038.4 | 0.00 | .85 | 117.0 | 0/ 3 | 0.0 |
| 22/ 53 | 0.0 | 900 | 10 | NO | - | 919.9 | 909.6 | 928.1 | 914.4 | 901.4 | 1042.3 | 0.00 | .85 | 117.0 | 0/ 3 | 0.0 |

# TABLE V-16

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

MIL-L-7808
BARE DUCT
SPRAY

| RUN/PT. | --- TEST -- CONDITIONS VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | THERMOCOUPLES T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | --- OVERALL --- LITES / ATTEMPT | M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9/ 1 | 2.0 | 1400 | 5 | YES | 1.7 | 1401.7 | 1394.2 | 1442.4 | 1386.4 | 1392.4 | 1647.1 | 2.00 | 7.32 | 99.8 | 3/ 3 | 225.0 |
| 9/ 2 | 4.0 | 1375 | 5 | YES | 1.6 | 1392.6 | 1402.1 | 1444.7 | 1385.9 | 1384.9 | 1653.5 | 4.03 | 7.33 | 100.0 | 1/ 1 | 150.0 |
| 9/ 3 | 6.0 | 1400 | 5 | NO | - | 1395.9 | 1407.6 | 1460.4 | 1396.3 | 1396.7 | 1690.1 | 6.00 | 7.30 | 99.4 | 2/ 5 | 75.0 |
| 9/ 4 | 6.0 | 1400 | 5 | YES | 5.7 | 1406.7 | 1408.5 | 1465.4 | 1401.4 | 1394.8 | 1694.9 | 5.97 | 7.30 | 99.3 | 2/ 5 | 75.0 |
| 9/ 5 | 8.0 | 1400 | 5 | NO | - | 1400.8 | 1401.7 | 1461.0 | 1394.8 | 1392.8 | 1700.0 | 8.05 | 7.27 | 98.7 | 0/ 4 | 1400.0 |
| 9/ 6 | 8.0 | 1400 | 5 | NO | - | 1410.3 | 1414.2 | 1469.4 | 1407.2 | 1397.2 | 1708.7 | 8.11 | 7.29 | 99.0 | 0/ 4 | 1400.0 |
| 9/ 7 | 8.0 | 1400 | 5 | NO | - | 1407.0 | 1406.3 | 1470.0 | 1401.1 | 1391.1 | 1707.3 | 7.97 | 7.28 | 98.8 | 0/ 4 | 1400.0 |
| 9/ 8 | 8.0 | 1400 | 5 | NO | - | 1404.4 | 1398.2 | 1462.5 | 1393.8 | 1388.9 | 1698.8 | 7.93 | 13.94 | 281.3 | 0/ 4 | 1400.0 |
| 9/ 9 | 6.0 | 1375 | 5 | YES | 5.9 | 1395.3 | 1414.0 | 1452.7 | 1391.0 | 1384.4 | 1682.4 | 5.98 | 14.02 | 284.2 | 2/ 2 | 50.0 |
| 9/ 10 | 4.0 | 1400 | 5 | YES | 5.5 | 1406.2 | 1408.0 | 1458.2 | 1397.1 | 1393.5 | 1676.1 | 4.04 | 14.03 | 284.5 | 1/ 1 | 175.0 |
| 9/ 11 | 2.0 | 1400 | 5 | YES | .6 | 1397.4 | 1398.1 | 1438.6 | 1382.6 | 1389.7 | 1641.9 | 1.97 | 14.01 | 283.7 | 3/ 3 | 225.0 |
| 9/ 12 | 2.0 | 1300 | 5 | YES | 8.0 | 1296.0 | 1291.3 | 1337.7 | 1277.5 | 1288.2 | 1508.9 | 2.05 | 14.01 | 284.1 | 3/ 4 | 125.0 |
| 9/ 13 | 2.0 | 1250 | 5 | YES | 6.0 | 1249.8 | 1248.5 | 1295.9 | 1239.1 | 1244.3 | 1454.2 | 1.96 | 14.00 | 283.6 | 4/ 6 | 75.0 |
| 9/ 14 | 2.0 | 1200 | 5 | NO | - | 1205.8 | 1195.2 | 1247.9 | 1188.4 | 1196.4 | 1389.3 | 1.97 | 13.99 | 283.0 | 1/ 5 | 25.0 |
| 9/ 15 | 2.0 | 1200 | 5 | NO | - | 1193.7 | 1193.2 | 1239.7 | 1184.7 | 1187.6 | 1376.9 | 1.97 | 13.98 | 282.5 | 1/ 5 | 25.0 |
| 9/ 16 | 2.0 | 1200 | 5 | NO | - | 1198.2 | 1195.1 | 1243.0 | 1186.4 | 1193.5 | 1379.1 | 1.97 | 7.26 | 98.5 | 1/ 5 | 25.0 |
| 9/ 17 | 2.0 | 1250 | 5 | YES | 5.6 | 1245.6 | 1254.3 | 1298.3 | 1235.5 | 1246.0 | 1455.9 | 1.96 | 7.28 | 98.8 | 4/ 6 | 75.0 |
| 9/ 18 | 4.0 | 1250 | 5 | NO | - | 1251.6 | 1252.3 | 1308.7 | 1244.7 | 1242.3 | 1480.9 | 4.15 | 7.22 | 97.5 | 1/ 5 | 25.0 |
| 9/ 19 | 4.0 | 1300 | 5 | NO | - | 1303.5 | 1311.0 | 1360.7 | 1297.6 | 1299.2 | 1551.0 | 4.00 | 7.16 | 96.4 | 2/ 3 | 75.0 |
| 9/ 20 | 4.0 | 1325 | 5 | YES | 5.7 | 1329.4 | 1327.4 | 1384.8 | 1321.9 | 1319.5 | 1579.8 | 3.94 | 7.14 | 95.9 | 2/ 2 | 100.0 |
| 9/ 21 | 4.0 | 1325 | 5 | YES | 5.5 | 1331.7 | 1334.5 | 1388.3 | 1325.5 | 1317.3 | 1583.7 | 3.96 | 7.14 | 95.9 | 2/ 2 | 100.0 |
| 9/ 22 | 4.0 | 1300 | 5 | YES | 5.7 | 1298.2 | 1290.0 | 1356.8 | 1293.8 | 1287.8 | 1538.3 | 4.00 | 7.11 | 95.3 | 2/ 3 | 75.0 |
| 9/ 23 | 4.0 | 1275 | 5 | YES | 6.3 | 1276.5 | 1276.5 | 1337.8 | 1279.4 | 1269.0 | 1513.7 | 4.02 | 7.05 | 94.0 | 1/ 1 | 50.0 |
| 9/ 24 | 4.0 | 1250 | 5 | YES | 6.0 | 1246.0 | 1245.6 | 1308.5 | 1244.8 | 1238.5 | 1477.7 | 4.07 | 7.07 | 94.6 | 1/ 5 | 25.0 |
| 9/ 25 | 4.0 | 1225 | 0 | NO | - | 1231.9 | 1223.4 | 1287.8 | 1222.6 | 1215.8 | 1455.5 | 4.01 | 7.05 | 94.0 | 0/ 4 | 0.0 |
| 9/ 26 | 4.0 | 1200 | 0 | NO | - | 1216.1 | 1218.9 | 1283.1 | 1219.6 | 1210.7 | 1440.6 | 4.04 | 7.03 | 93.7 | 0/ 0 | -25.0 |
| 9/ 27 | 1.0 | 1200 | 0 | NO | - | 1200.7 | 1191.4 | 1242.6 | 1190.6 | 1196.7 | 1384.8 | 1.06 | 6.99 | 92.8 | 2/ 2 | 200.0 |
| 9/ 28 | 2.0 | 1225 | 0 | NO | - | 1226.9 | 1220.7 | 1275.1 | 1214.1 | 1217.8 | 1429.9 | 2.05 | 6.92 | 91.4 | 2/ 4 | 50.0 |
| 9/ 29 | 0.0 | 1225 | 0 | NO | - | 1222.9 | 1162.1 | 1250.5 | 1152.0 | 1213.6 | 1360.5 | 0.00 | 7.47 | 102.9 | 1/ 1 | 25.0 |
| 9/ 30 | 0.0 | 1300 | 0 | NO | - | 1304.6 | 1229.9 | 1333.5 | 1230.6 | 1293.8 | 1466.7 | 0.00 | 7.47 | 103.0 | 1/ 1 | 100.0 |
| 9/ 31 | 0.0 | 1375 | 0 | NO | - | 1398.9 | 1336.8 | 1431.5 | 1326.9 | 1385.4 | 1590.4 | 0.00 | 7.43 | 102.2 | 0/ 0 | 175.0 |
| 9/ 32 | 1.0 | 1400 | 0 | NO | - | 1400.9 | 1391.0 | 1436.8 | 1372.3 | 1398.9 | 1612.5 | .96 | 7.44 | 102.3 | 1/ 1 | 400.0 |
| 9/ 33 | 1.0 | 1400 | 0 | NO | - | 1407.7 | 1386.6 | 1435.3 | 1375.2 | 1392.8 | 1619.8 | 1.00 | 7.42 | 101.8 | 1/ 1 | 400.0 |
| 9/ 34 | 2.0 | 1250 | 5 | YES | 6.3 | 1256.2 | 1259.9 | 1304.3 | 1245.6 | 1243.2 | 1465.4 | 1.97 | 7.49 | 103.3 | 4/ 6 | 75.0 |
| 9/ 35 | 2.0 | 1225 | 5 | NO | - | 1224.5 | 1230.4 | 1274.7 | 1220.2 | 1217.7 | 1428.5 | 1.94 | 7.53 | 104.3 | 2/ 4 | 50.0 |
| 9/ 36 | 2.0 | 1225 | 5 | YES | 6.1 | 1226.2 | 1230.7 | 1287.7 | 1222.7 | 1227.6 | 1439.0 | 1.94 | 7.54 | 104.3 | 2/ 4 | 50.0 |
| 9/ 37 | 1.0 | 1225 | 5 | YES | 7.1 | 1225.6 | 1210.9 | 1267.8 | 1218.5 | 1221.8 | 1405.5 | .90 | 7.53 | 104.2 | 1/ 1 | 225.0 |
| 9/ 38 | 1.0 | 1200 | 5 | YES | 7.7 | 1201.1 | 1188.3 | 1234.4 | 1181.8 | 1195.3 | 1370.3 | .99 | 7.54 | 104.5 | 2/ 2 | 200.0 |
| 9/ 39 | 1.0 | 1175 | 5 | NO | - | 1174.7 | 1167.8 | 1208.3 | 1154.2 | 1168.9 | 1345.4 | .98 | 7.53 | 104.2 | 1/ 3 | 175.0 |
| 9/ 40 | 1.0 | 1175 | 5 | NO | - | 1182.9 | 1171.0 | 1226.5 | 1158.7 | 1181.4 | 1361.9 | 1.02 | 7.52 | 104.0 | 1/ 3 | 175.0 |

# TABLE V-16



F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

MIL-L-7808
BARE DUCT
SPRAY

| RUN/PT. | --- TEST -- CONDITIONS VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | THERMOCOUPLES T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | --- OVERALL --- LITES / ATTEMPT | M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9/ 41 | 0.0 | 1300 | 5 | YES | 6.0 | 1296.7 | 1241.8 | 1337.8 | 1235.8 | 1294.0 | 1462.6 | 0.00 | 7.52 | 104.0 | 1/ 1 | 100.0 |
| 9/ 42 | 0.0 | 1225 | 5 | YES | 6.2 | 1241.5 | 1186.6 | 1277.9 | 1181.5 | 1236.3 | 1384.1 | 0.00 | 7.47 | 103.0 | 1/ 1 | 25.0 |
| 9/ 43 | 0.0 | 1200 | 5 | NO | - | 1191.5 | 1134.6 | 1230.2 | 1132.9 | 1188.9 | 1336.3 | 0.00 | 7.50 | 103.5 | 0/ 5 | 0.0 |
| 9/ 44 | 0.0 | 1200 | 5 | NO | - | 1210.6 | 1153.8 | 1250.9 | 1149.0 | 1204.8 | 1359.7 | 0.00 | 7.50 | 103.5 | 0/ 5 | 0.0 |
| 12/100 | 2.0 | 1250 | 5 | NO | - | 1268.8 | 1243.9 | 1300.3 | 76.1 | 1255.3 | 1485.1 | 1.98 | 7.37 | 100.7 | 4/ 6 | 75.0 |
| 12/101 | 2.0 | 1250 | 5 | NO | - | 1267.2 | 1253.6 | 1298.8 | 73.3 | 1250.4 | 1486.7 | 1.99 | 7.33 | 100.0 | 4/ 6 | 75.0 |
| 12/102 | 2.0 | 1300 | 5 | YES | 6.2 | 1317.4 | 1300.9 | 1338.8 | 74.3 | 1301.6 | 1543.6 | 2.03 | 7.31 | 99.6 | 3/ 4 | 125.0 |
| 12/103 | 2.0 | 1300 | 5 | NO | - | 1317.0 | 1303.6 | 1343.2 | 73.4 | 1298.5 | 1538.9 | 1.96 | 7.24 | 98.0 | 3/ 4 | 125.0 |
| 12/104 | 2.0 | 1400 | 5 | YES | .7 | 1410.4 | 1403.6 | 1435.8 | 75.1 | 1404.7 | 1650.1 | 1.98 | 8.55 | 126.6 | 3/ 3 | 225.0 |
| 12/105 | 2.0 | 1300 | 5 | YES | 6.2 | 1319.4 | 1295.3 | 1332.6 | 74.4 | 1299.3 | 1521.2 | 1.99 | 8.48 | 125.0 | 3/ 4 | 125.0 |
| 12/106 | 2.0 | 1250 | 5 | YES | 6.6 | 1267.2 | 1251.1 | 1289.5 | 73.7 | 1251.3 | 1467.5 | 1.96 | 8.43 | 123.9 | 4/ 6 | 75.0 |
| 12/107 | 2.0 | 1200 | 5 | NO | - | 1218.9 | 1203.2 | 1247.1 | 76.3 | 1205.8 | 1409.1 | 1.99 | 8.38 | 122.8 | 1/ 5 | 25.0 |
| 12/108 | 2.0 | 1225 | 5 | NO | - | 1247.1 | 1226.1 | 1276.6 | 73.8 | 1227.1 | 1454.2 | 2.00 | 8.33 | 121.7 | 2/ 4 | 50.0 |
| 12/109 | 2.0 | 1225 | 5 | YES | 7.2 | 1247.1 | 1232.9 | 1281.9 | 73.1 | 1226.6 | 1461.4 | 2.00 | 8.27 | 120.4 | 2/ 4 | 50.0 |
| 12/110 | 2.0 | 1200 | 5 | YES | 7.5 | 1215.9 | 1207.4 | 1256.6 | 72.9 | 1194.7 | 1425.3 | 2.04 | 8.24 | 119.7 | 1/ 5 | 25.0 |
| 12/111 | 2.0 | 1175 | 5 | NO | - | 1196.2 | 1180.0 | 1231.3 | 75.1 | 1175.6 | 1391.4 | 2.01 | 8.18 | 118.3 | 0/ 3 | 0.0 |
| 12/112 | 2.0 | 1175 | 5 | NO | - | 1198.8 | 1186.6 | 1236.6 | 76.3 | 1173.3 | 1402.8 | 2.01 | 8.15 | 117.7 | 0/ 3 | 0.0 |
| 12/113 | 2.0 | 1175 | 5 | NO | - | 1195.4 | 1186.1 | 1234.3 | 74.1 | 1169.3 | 1400.7 | 2.01 | 8.11 | 116.8 | 0/ 3 | 0.0 |
| 12/114 | 4.0 | 1350 | 5 | NO | - | 1371.8 | 1365.4 | 1409.5 | 73.4 | 1351.6 | 1630.4 | 4.02 | 8.68 | 129.5 | 1/ 2 | 125.0 |
| 12/115 | 4.0 | 1350 | 5 | YES | 6.4 | 1372.2 | 1353.9 | 1410.0 | 74.1 | 1350.0 | 1630.8 | 4.00 | 8.60 | 127.6 | 1/ 2 | 125.0 |
| 12/116 | 4.0 | 1300 | 5 | YES | 5.8 | 1321.2 | 1314.8 | 1361.2 | 76.9 | 1302.5 | 1566.0 | 4.02 | 8.48 | 125.0 | 2/ 3 | 75.0 |
| 12/117 | 4.0 | 1250 | 5 | NO | - | 1268.9 | 1256.0 | 1310.2 | 72.7 | 1248.5 | 1501.7 | 3.96 | 8.36 | 122.2 | 1/ 5 | 25.0 |
| 12/118 | 4.0 | 1250 | 5 | NO | - | 1271.1 | 1263.9 | 1314.7 | 75.8 | 1247.8 | 1505.9 | 3.96 | 8.59 | 127.4 | 1/ 5 | 25.0 |
| 12/119 | 4.0 | 1250 | 5 | NO | - | 1277.3 | 1254.6 | 1318.9 | 75.3 | 1248.4 | 1514.5 | 3.93 | 8.52 | 125.9 | 1/ 5 | 25.0 |
| 12/120 | 4.0 | 1225 | 5 | NO | - | 1242.2 | 1230.8 | 1290.8 | 75.0 | 1222.4 | 1479.0 | 4.05 | 8.37 | 122.4 | 0/ 4 | 0.0 |
| 12/121 | 4.0 | 1050 | 5 | NO | - | 1067.4 | 1042.2 | 1109.7 | 74.4 | 1048.3 | 1262.3 | 3.91 | 8.22 | 119.1 | 0/ 1 | -175.0 |
| 12/122 | 2.0 | 1050 | 5 | NO | - | 1065.4 | 1051.1 | 1100.2 | 72.2 | 1051.1 | 1236.2 | 1.98 | 8.14 | 117.4 | 0/ 1 | -125.0 |
| 12/123 | 1.0 | 1050 | 5 | NO | - | 1068.8 | 1043.3 | 1075.6 | 74.6 | 1048.2 | 1207.2 | 1.04 | 8.61 | 127.9 | 1/ 2 | 50.0 |
| 12/124 | 6.0 | 1400 | 0 | NO | - | 1429.2 | 1415.6 | 1470.4 | 78.7 | 1401.6 | 1708.7 | 5.97 | 8.47 | 124.9 | 2/ 5 | 75.0 |
| 12/125 | 6.0 | 1400 | 0 | NO | - | 1426.8 | 1416.2 | 1468.0 | 75.8 | 1401.1 | 1711.9 | 5.96 | 8.48 | 125.1 | 2/ 5 | 75.0 |
| 12/126 | 6.0 | 1400 | 5 | NO | - | 1428.1 | 1417.4 | 1465.1 | 73.9 | 1404.3 | 1710.1 | 6.01 | 9.10 | 139.1 | 2/ 5 | 75.0 |
| 12/127 | 6.0 | 1400 | 5 | NO | - | 1422.0 | 1414.8 | 1465.3 | 73.3 | 1399.1 | 1703.5 | 6.06 | 9.11 | 139.4 | 2/ 5 | 75.0 |
| 12/128 | 6.0 | 1400 | 5 | YES | 5.6 | 1426.1 | 1413.8 | 1470.4 | 75.7 | 1400.4 | 1710.6 | 6.01 | 13.68 | 271.1 | 2/ 5 | 75.0 |
| 12/129 | 6.0 | 1375 | 5 | YES | 5.8 | 1402.0 | 1401.4 | 1451.7 | 76.5 | 1377.4 | 1693.7 | 5.98 | 13.70 | 271.9 | 2/ 2 | 50.0 |
| 12/130 | 6.0 | 1350 | 5 | YES | 5.8 | 1374.2 | 1378.3 | 1430.1 | 76.2 | 1350.0 | 1657.6 | 6.06 | 13.70 | 272.0 | 1/ 1 | 25.0 |
| 12/131 | 6.0 | 1325 | 5 | NO | - | 1359.3 | 1355.2 | 1413.3 | 73.7 | 1325.3 | 1640.9 | 5.99 | 13.69 | 271.6 | 0/ 3 | 0.0 |
| 12/132 | 6.0 | 1325 | 5 | NO | - | 1353.4 | 1359.9 | 1419.6 | 74.8 | 1324.5 | 1648.0 | 6.01 | 13.67 | 270.8 | 0/ 3 | 0.0 |
| 12/133 | 6.0 | 1325 | 5 | NO | - | 1365.9 | 1360.3 | 1424.3 | 77.6 | 1328.1 | 1655.1 | 6.07 | 13.65 | 270.1 | 0/ 3 | 0.0 |
| 12/134 | 4.0 | 1225 | 0 | YES | 5.7 | 1278.1 | 1285.0 | 1350.5 | 76.3 | 1226.5 | 1551.7 | 3.98 | 13.62 | 268.9 | 0/ 4 | 0.0 |
| 12/135 | 4.0 | 1225 | 5 | NO | - | 1260.4 | 1267.6 | 1321.9 | 76.4 | 1226.3 | 1518.5 | 4.04 | 13.61 | 268.6 | 0/ 4 | 0.0 |

# TABLE V-16

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

MIL-L-7808
BARE DUCT
SPRAY

| RUN/PT. | --- TEST -- CONDITIONS VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | THERMOCOUPLES T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | --- OVERALL --- LITES / ATTEMPT | M.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/136 | 4.0 | 1225 | 5 | NO | - | 1247.8 | 1269.8 | 1327.9 | 76.3 | 1224.0 | 1524.6 | 4.04 | 13.59 | 268.0 | 0/ 4 | 0.0 |
| 12/137 | 4.0 | 1225 | 5 | NO | - | 1250.9 | 1272.3 | 1335.1 | 72.9 | 1217.1 | 1531.8 | 3.99 | 13.58 | 267.4 | 0/ 4 | 0.0 |
| 12/138 | 1.0 | 1400 | 5 | YES | 5.4 | 1425.5 | 1452.6 | 1472.2 | 77.0 | 1403.4 | 1697.0 | 1.00 | 13.88 | 278.9 | 1/ 1 | 400.0 |
| 12/139 | 1.0 | 1350 | 5 | YES | 5.4 | 1382.1 | 1399.5 | 1421.8 | 72.8 | 1351.1 | 1634.4 | .90 | 13.86 | 278.1 | 1/ 1 | 350.0 |
| 12/140 | 1.0 | 1300 | 5 | YES | 5.5 | 1327.3 | 1339.3 | 1368.1 | 74.1 | 1298.3 | 1563.7 | .92 | 13.86 | 278.0 | 1/ 1 | 300.0 |
| 12/141 | 1.0 | 1250 | 5 | YES | 5.5 | 1278.4 | 1305.4 | 1321.5 | 75.9 | 1252.2 | 1507.6 | .97 | 13.85 | 277.6 | 1/ 1 | 250.0 |
| 12/142 | 1.0 | 1200 | 5 | YES | 6.1 | 1223.1 | 1241.7 | 1266.8 | 73.6 | 1195.5 | 1435.4 | .98 | 13.85 | 277.6 | 2/ 2 | 200.0 |
| 12/143 | 1.0 | 1175 | 5 | YES | 6.2 | 1201.9 | 1223.4 | 1254.2 | 76.6 | 1174.7 | 1417.0 | .95 | 13.84 | 277.5 | 1/ 3 | 175.0 |
| 12/144 | 1.0 | 1150 | 5 | YES | 5.9 | 1164.9 | 1201.8 | 1226.5 | 74.1 | 1149.2 | 1387.5 | .98 | 13.85 | 277.7 | 1/ 1 | 150.0 |
| 12/145 | 1.0 | 1125 | 5 | YES | 7.0 | 1143.9 | 1161.7 | 1196.3 | 73.0 | 1124.0 | 1351.5 | 1.03 | 13.84 | 277.2 | 1/ 1 | 125.0 |
| 12/146 | 1.0 | 1100 | 5 | YES | 6.2 | 1117.0 | 1137.9 | 1179.3 | 71.4 | 1096.3 | 1327.1 | 1.01 | 13.84 | 277.4 | 1/ 1 | 100.0 |
| 12/147 | 1.0 | 1050 | 5 | YES | 6.8 | 1071.5 | 1091.4 | 1128.7 | 75.5 | 1051.2 | 1262.2 | 1.03 | 13.85 | 277.6 | 1/ 2 | 50.0 |
| 12/148 | 1.0 | 1000 | 5 | NO | - | 1014.1 | 1038.9 | 1081.7 | 75.1 | 1000.8 | 1202.5 | .99 | 13.84 | 277.5 | 0/ 3 | 0.0 |
| 12/149 | 1.0 | 1000 | 5 | NO | - | 1026.5 | 1038.5 | 1090.0 | 74.9 | 999.4 | 1202.0 | 1.02 | 13.84 | 277.2 | 0/ 3 | 0.0 |
| 12/150 | 1.0 | 1000 | 5 | NO | - | 1020.1 | 1035.8 | 1090.3 | 73.7 | 992.4 | 1202.6 | .95 | 13.84 | 277.1 | 0/ 3 | 0.0 |
| 12/151 | 7.0 | 1350 | 5 | YES | 5.8 | 1384.8 | 1437.2 | 1473.6 | 75.7 | 1354.3 | 1728.6 | 7.07 | 13.85 | 277.7 | 1/ 1 | 25.0 |
| 12/152 | 7.0 | 1325 | 5 | NO | - | 1353.0 | 1406.7 | 1447.8 | 77.9 | 1325.6 | 1695.7 | 6.99 | 13.84 | 277.3 | 0/ 3 | 0.0 |
| 12/153 | 7.0 | 1325 | 5 | NO | - | 1365.8 | 1410.4 | 1460.9 | 77.3 | 1326.1 | 1714.5 | 7.04 | 13.83 | 277.1 | 0/ 3 | 0.0 |
| 12/154 | 7.0 | 1325 | 5 | NO | - | 1362.3 | 1416.9 | 1460.3 | 77.3 | 1324.1 | 1713.3 | 6.96 | 13.82 | 276.6 | 0/ 3 | 0.0 |
| 12/155 | 0.0 | 1200 | 5 | NO | - | 1221.6 | 1198.8 | 1267.0 | 73.8 | 1201.4 | 1397.3 | 0.00 | 13.83 | 277.0 | 0/ 5 | 0.0 |
| 12/156 | 0.0 | 1200 | 5 | NO | - | 1235.1 | 1216.6 | 1290.3 | 77.4 | 1211.8 | 1428.8 | 0.00 | 13.83 | 276.8 | 0/ 5 | 0.0 |
| 12/157 | 0.0 | 1200 | 5 | NO | - | 1230.7 | 1218.5 | 1287.7 | 73.1 | 1201.2 | 1430.5 | 0.00 | 13.81 | 276.2 | 0/ 5 | 0.0 |

# TABLE V-17

F-16 ENGINE-NACELLE FIRE PROTECTION STUDY
CCP 5704
COMPLETE RUN SUMMARY

MIL-L-7808
BARE DUCT
DRIP

| RUN/PT. | --- TEST -- CONDITIONS VEL | TEMP | INJ. TIME | IGN. (Y/N) | COMB TIME | THERMOCOUPLES T1 | T2 | T3 | T4 | T5 | T6 | NAC. VEL. | FUEL FLOW | FUEL REG. | --- OVERALL --- LITES / ATTEMPT | H.I.T. DELTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/ 1 | 2.0 | 1400 | 10 | YES | 10.7 | 1403.5 | 1402.2 | 1438.5 | 1403.7 | 1399.8 | 1672.5 | 1.99 | 2.01 | 135.0 | 1/ 1 | 175.0 |
| 10/ 2 | 2.0 | 1350 | 10 | YES | 10.9 | 1359.8 | 1347.0 | 1379.8 | 1347.1 | 1339.6 | 1599.2 | 1.99 | 2.01 | 135.0 | 1/ 1 | 125.0 |
| 10/ 3 | 2.0 | 1300 | 10 | YES | 10.8 | 1301.5 | 1303.0 | 1341.5 | 1306.9 | 1294.6 | 1551.2 | 2.00 | 2.01 | 135.0 | 1/ 1 | 75.0 |
| 10/ 4 | 2.0 | 1275 | 10 | NO | - | 1282.4 | 1282.6 | 1321.1 | 1289.6 | 1272.4 | 1523.2 | 2.00 | 2.01 | 135.0 | 1/ 2 | 50.0 |
| 10/ 5 | 2.0 | 1275 | 10 | YES | 10.8 | 1292.9 | 1290.8 | 1337.1 | 1299.3 | 1278.5 | 1535.4 | 1.98 | 2.01 | 135.0 | 1/ 2 | 50.0 |
| 10/ 6 | 2.0 | 1250 | 10 | NO | - | 1264.9 | 1258.0 | 1298.5 | 1265.4 | 1246.9 | 1493.9 | 1.94 | 2.01 | 135.0 | 1/ 2 | 25.0 |
| 10/ 7 | 2.0 | 1250 | 10 | YES | 11.0 | 1256.4 | 1254.0 | 1303.8 | 1263.9 | 1244.0 | 1502.8 | 1.99 | 2.01 | 135.0 | 1/ 2 | 25.0 |
| 10/ 8 | 2.0 | 1225 | 10 | NO | - | 1240.3 | 1230.0 | 1279.7 | 1243.2 | 1222.4 | 1469.2 | 1.95 | 2.01 | 135.0 | 0/ 3 | 0.0 |
| 10/ 9 | 2.0 | 1225 | 10 | NO | - | 1236.0 | 1237.6 | 1289.3 | 1254.2 | 1226.1 | 1482.2 | 1.99 | 2.01 | 135.0 | 0/ 3 | 0.0 |
| 10/ 10 | 2.0 | 1225 | 10 | NO | - | 1224.9 | 1234.6 | 1283.3 | 1248.2 | 1216.7 | 1474.9 | 1.97 | 2.01 | 135.0 | 0/ 3 | 0.0 |
| 10/ 11 | 4.0 | 1350 | 10 | YES | 10.9 | 1370.6 | 1367.2 | 1410.5 | 1367.7 | 1348.1 | 1637.1 | 3.99 | 2.01 | 135.0 | 1/ 1 | 50.0 |
| 10/ 12 | 4.0 | 1325 | 10 | YES | 11.0 | 1343.5 | 1342.7 | 1390.7 | 1346.9 | 1327.2 | 1612.2 | 3.96 | 2.01 | 135.0 | 1/ 1 | 25.0 |
| 10/ 13 | 4.0 | 1300 | 10 | NO | - | 1316.3 | 1313.0 | 1365.3 | 1322.5 | 1296.5 | 1579.5 | 3.94 | 2.01 | 135.0 | 0/ 3 | 0.0 |
| 10/ 14 | 4.0 | 1300 | 10 | NO | - | 1313.5 | 1308.0 | 1363.0 | 1322.1 | 1294.1 | 1577.2 | 3.99 | 2.01 | 135.0 | 0/ 3 | 0.0 |
| 10/ 15 | 4.0 | 1300 | 10 | NO | - | 1310.5 | 1316.0 | 1370.5 | 1328.0 | 1300.5 | 1594.0 | 3.94 | 2.01 | 135.0 | 0/ 3 | 0.0 |
| 10/ 16 | 6.0 | 1400 | 10 | YES | 10.8 | 1410.7 | 1417.7 | 1465.5 | 1416.1 | 1394.4 | 1718.4 | 6.02 | 2.01 | 135.0 | 1/ 1 | 25.0 |
| 10/ 17 | 6.0 | 1375 | 10 | NO | - | 1394.8 | 1400.8 | 1448.0 | 1397.9 | 1377.6 | 1699.5 | 6.06 | 2.01 | 135.0 | 0/ 3 | 0.0 |
| 10/ 18 | 6.0 | 1375 | 10 | NO | - | 1378.0 | 1399.6 | 1451.2 | 1404.2 | 1371.1 | 1699.3 | 5.99 | 2.01 | 135.0 | 0/ 3 | 0.0 |
| 10/ 19 | 6.0 | 1375 | 10 | NO | - | 1394.4 | 1401.1 | 1456.6 | 1418.2 | 1380.8 | 1719.3 | 6.01 | 2.01 | 135.0 | 0/ 3 | 0.0 |
| 10/ 20 | 1.0 | 1275 | 10 | YES | 11.0 | 1289.5 | 1279.8 | 1310.9 | 1272.8 | 1283.0 | 1470.4 | 1.02 | 2.01 | 135.0 | 2/ 3 | 25.0 |
| 10/ 21 | 1.0 | 1250 | 10 | NO | - | 1271.1 | 1253.9 | 1287.4 | 1252.6 | 1252.9 | 1454.3 | .91 | 2.01 | 135.0 | 0/ 3 | 0.0 |
| 10/ 22 | 1.0 | 1250 | 10 | NO | - | 1265.3 | 1253.4 | 1290.1 | 1257.4 | 1252.4 | 1460.6 | 1.12 | 2.01 | 135.0 | 0/ 3 | 0.0 |
| 10/ 23 | 1.0 | 1250 | 10 | NO | - | 1256.1 | 1257.9 | 1298.2 | 1261.8 | 1254.3 | 1469.5 | .98 | 2.01 | 135.0 | 0/ 3 | 0.0 |
| 10/ 24 | 1.0 | 1275 | 10 | NO | - | 1310.1 | 1291.4 | 1321.2 | 1283.5 | 1283.9 | 1498.7 | 1.11 | 2.01 | 135.0 | 2/ 3 | 25.0 |
| 10/ 25 | 1.0 | 1275 | 10 | YES | 11.1 | 1297.4 | 1287.0 | 1325.3 | 1292.2 | 1281.5 | 1505.1 | .97 | 2.01 | 135.0 | 2/ 3 | 25.0 |
| 10/ 26 | 0.0 | 1375 | 10 | YES | 11.0 | 1389.4 | 1335.9 | 1408.9 | 1328.6 | 1377.3 | 1579.2 | 0.00 | 2.01 | 135.0 | 1/ 1 | 100.0 |
| 10/ 27 | 0.0 | 1350 | 10 | YES | 11.0 | 1365.6 | 1301.0 | 1390.8 | 1309.9 | 1347.8 | 1553.0 | 0.00 | 2.01 | 135.0 | 1/ 1 | 75.0 |
| 10/ 28 | 0.0 | 1325 | 10 | YES | 11.0 | 1336.8 | 1294.3 | 1371.0 | 1288.8 | 1330.2 | 1519.7 | 0.00 | 2.01 | 135.0 | 1/ 1 | 50.0 |
| 10/ 29 | 0.0 | 1300 | 10 | YES | 11.0 | 1309.9 | 1262.3 | 1344.9 | 1266.2 | 1305.0 | 1501.7 | 0.00 | 2.01 | 135.0 | 1/ 1 | 25.0 |
| 10/ 30 | 0.0 | 1275 | 10 | NO | - | 1291.7 | 1234.5 | 1318.1 | 1239.2 | 1277.7 | 1465.5 | 0.00 | 2.01 | 135.0 | 0/ 4 | 0.0 |
| 10/ 31 | 0.0 | 1275 | 10 | NO | - | 1283.3 | 1233.0 | 1323.5 | 1244.7 | 1278.2 | 1471.4 | 0.00 | 2.01 | 135.0 | 0/ 4 | 0.0 |
| 10/ 32 | 0.0 | 1275 | 10 | NO | - | 1273.0 | 1229.4 | 1323.4 | 1245.0 | 1277.4 | 1470.6 | 0.00 | 2.01 | 135.0 | 0/ 4 | 0.0 |
| 10/ 33 | 0.0 | 1275 | 2 | NO | - | 1286.0 | 1233.1 | 1326.9 | 1245.2 | 1275.5 | 1471.8 | 0.00 | 2.01 | 135.0 | 0/ 4 | 0.0 |

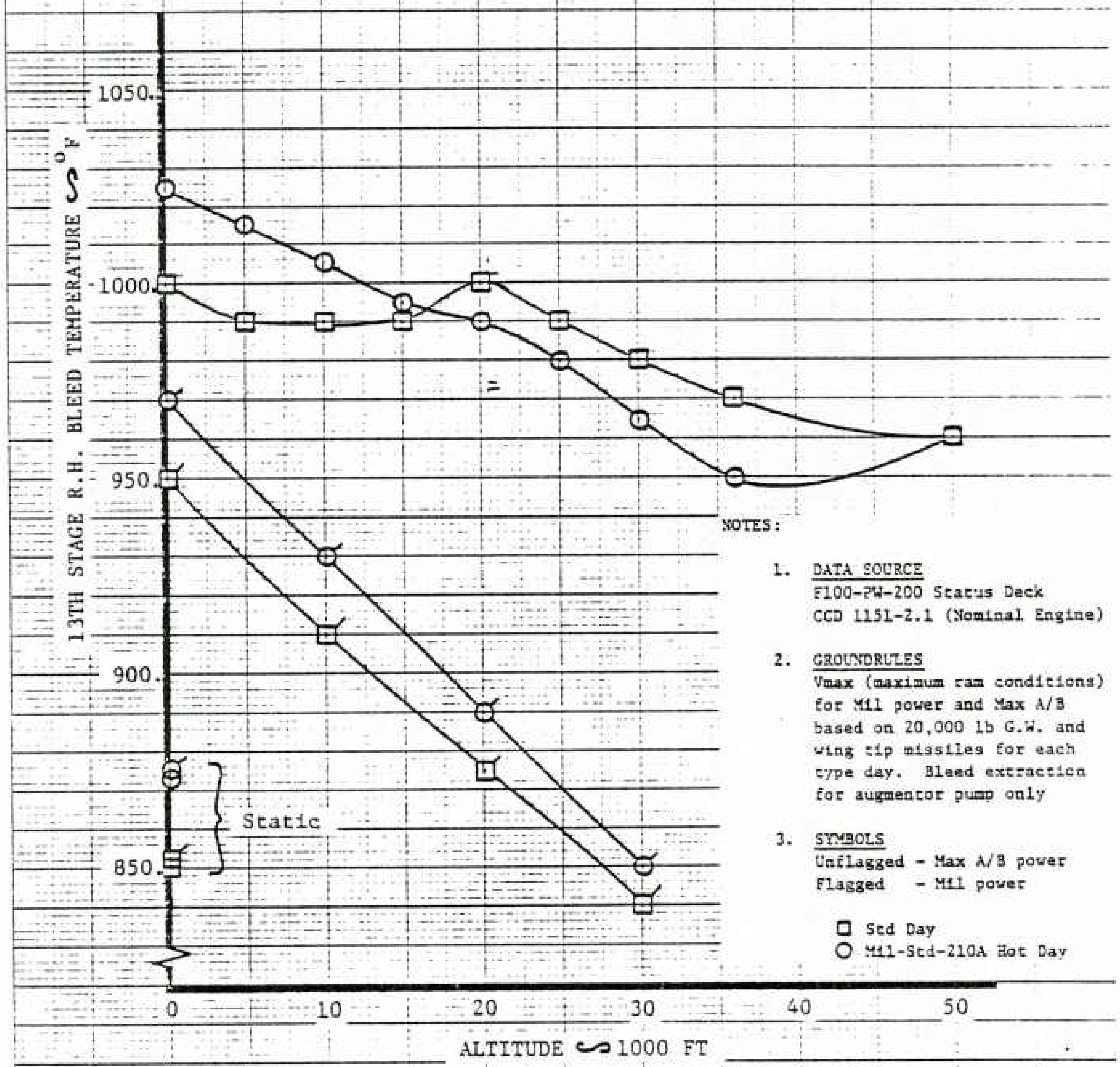
# APPENDIX VI

## MAXIMUM TEMPERATURE - 13th STAGE BLEED DUCT

Figure VI-1 presents the 13th stage bleed duct temperatures as provided by P&W/GPD. The data were based on the General Dynamics supplied F-16 flight envelope limits (maximim ram conditions) for both Intermediate and Maximum Augmentation and standard and hot atmospheres

FIGURE VI-1

MAXIMUM TEMPERATURE - 13th STAGE BLEED DUCT



## APPENDIX B

## $GN_2$ and NEA FIRE EXTINGUISHANT TESTS

A brief series of fire extinguishant tests using $GN_2$ and NEA6 and NEA9 was conducted in early 1981 as part of the AEN test facility checkout test program. The test set-up used the flameholder and fuel injector used for the test facility fire checkout tests, and the Halon injection system and manifold described in Section 3.1.1 and shown in Figures 3-1 and 3-2.

There were a total of 44 runs conducted to establish the percent extinguishant required as a function of ventilating air velocity. A plot of all the data points is shown in Figure B-1. All tests were conducted with a 1-second extinguishant dump duration. Fire knockdowns were obtained with all three agents tested ($GN_2$, NEA6, NEA9). There were three 3 "control tests" conducted by dumping air only, to ensure that the pulsation in flow alone, did not knockdown the fire. The air dumps did not knockdown the fire but did produce a distinct drop in fire intensity for a short period of time, indicating that the "quick pulse" type of injection does contribute, to some extent, to fire knockdown.

The NEA was prepared by filling the extinguishant container tank with nitrogen and air in the proper proportionate partial pressures. The quantity of extinguishant injected during the 1-second dump period was controlled by varying the tank fill pressure. The weight injected was calculated from the tank temperatures and pressures before and after the dump using the ideal gas law.

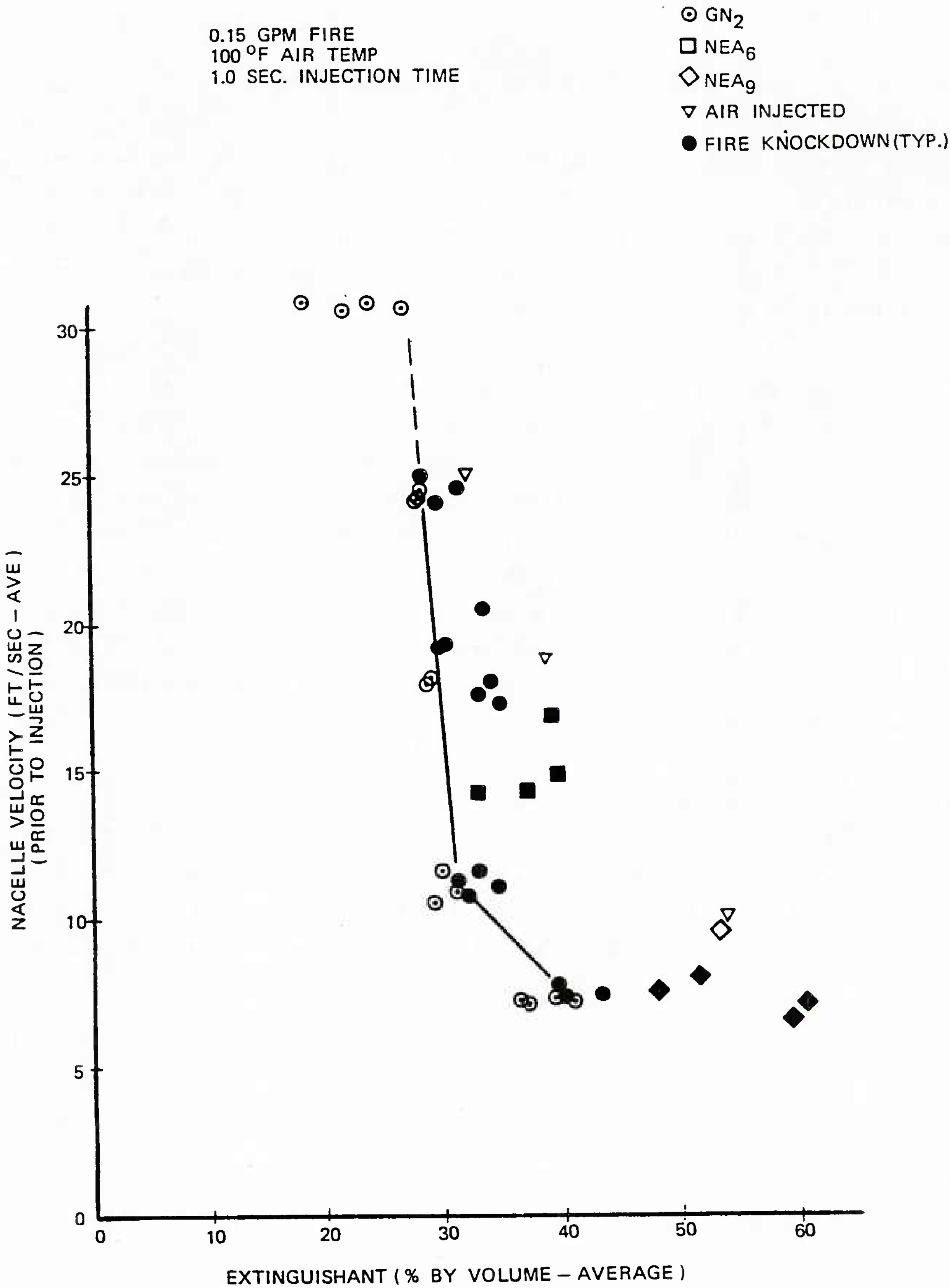



*Figure B-1. $GN_2$ & NEA Extinguishant Test with Equal Distribution Injection*

# APPENDIX C

## CALCULATIONS AND ANALYSIS SUPPORTING BATTLE DAMAGE SIMULATION

Three types of damage which might occur in the F-16 nacelle are considered:

- o A 23 mm HEI burst inside the nacelle cavity causing a hole in the nacelle outer wall.
- o A ruptured or perforated bleed line.
- o Fan perforation.

The following analysis deals with how these events would alter the ventilation airflow within the nacelle:

### C-1.0 HEI "Flower" in Nacelle Wall:

For this analysis, it is assumed that a 23 mm HEI burst occurs inside the nacelle inflicting a HEI "Flower" type hole in the outside of the nacelle. This is assumed to be .4 $ft^2$ (56.7 $in^2$) in area (Ref. 2). The changes in airflow are discussed in Section C-4.0. The test conditions for a "worst case" simulation of this type of battle damage are included in Table C-1.

### C-2.0 Ruptured or Perforated Bleed Line

Fire and overheat incidents on F-111 airplanes which occurred between 1967 and 1973 were obtained from Gandee (Ref. C-1). Bleed duct and bleed duct clamp failures amounted to 11 out of 33 total incidents. While these incidents usually resulted in nacelle damage due to the impingement of large volumes of hot air, no fires resulted.

A 23 mm HEI could rupture the bleed duct of the F-16. If the rupture occurred at the engine bleed port, up to 30 lbs/sec of 1200$^{0}$F air at 568 psia would be vented into the nacelle cavity in the case of sea level Mach 1.2 maximum augmented power. If additional openings in the nacelle were not created by

Table C-1. Battle Damage Simulation in AENFTS

| F-16 Flight Condition | Normal F-16 Ventilation Airflow per Flt. Test Report | Equivalent Airflow in F-16 Simulator in AEN to Match Average Vel's. at Amb. Cond's. * | ESTIMATED CHANGE DUE TO DAMAGE IN ACTUAL F-16: HEI "Flower" in Nacelle per Attached Boeing Memo | Bleed Duct Failure | Bleed Duct Perforation (.5 Inch Dia Hole) | Fan Perforation (1.0 Inch Dia. Hole) |
|---|---|---|---|---|---|---|
| Take-off, Max Augmented Power | 6 fps @ $60^o$ F | .72 pps | Up to 1 pps Inflow and Reduced Flow in Nacelle Upstream of Damage | up to 17 pps Inflow @ $1000^o$ F | .74 pps Inflow @ $1000^o$ F | .52 pps Inflow @ $306^o$ F |
| Mach 1.2, Sea-level Flight | 27 fps @ $208^o$ F | 3.26 pps | From .06 pps Outflow to 5.8 pps Inflow | Up to 30 pps Inflow @ $1164^o$ F | 1.18 pps Inflow @ $1164^o$ F | .80 pps Inflow @ $424^o$ F |
| Mach .8, 35K Cruise | 20 fps @ $-15^o$ F | 2.42 pps | From .82 pps Outflow to .75 pps Inflow | Up to 10 pps Inflow @ $922^o$ F | .48 pps Inflow @ $922^o$ F | .34 pps Inflow @ $261^o$ F |

* F-16 Simulator Flow Area = 232 $in^2$

PLANNED TESTS FOR F-16 NACELLE SIMULATOR IN AEN BASED ON WORST SURVIVABLE CASES WHICH CAN BE SIMULATED:

1. HEI "Flower" with approximately 40 % outflow
2. 1 pps @ 424 $^o$ F inflow from fan perforation
3. 1 pps @ $1200^o$ F inflow from bleed duct perforation

With test conditions at 1, 2.5, 4, 5.5 and 7 pps total nacelle ventilation airflow the flow impingement, the flow would choke the nacelle exit, inlet and fire doors. Nacelle internal velocities around 100 ft/sec would result from total rupture. Nacelle fires would be as unlikely on the F-16 with these failures as on the F-111 because of the high velocities within the nacelle.

Perforation of the bleed duct by HEI fragments would allow smaller quantities of bleed flow to enter the nacelle cavity and might create a situation more likely to support a nacelle fire. The new bleed air heating system for the AEN is limited to 1 lb/sec. The best battle damage simulation in terms of a nacelle environment which would support a fire and where the performance of the fire extinguishing system would be most taxed may be to leave the forward duct marmon clamp loose and vent the entire 1 lb/sec. of hot bleed flow into the nacelle.

The following data were obtained from a P&WA F-100 engine performance deck for F-16 installed hot day conditions:

| Flight Condition | Bleed Air Pressure (psia) | Bleed Air Temperature ($^{0}$R) |
|---|---|---|
| T/O, Mach = 0, Max Aug. Pwr. | 342 | 1473 |
| S/L, Mach 1.2, Max. Aug. Pwr. | 568 | 1624 |
| 20K, Mach .8, Max. Continuous | 215 | 1382 |

C-3.0 Fan Perforation

Because it provides lower nacelle velocities, the case of a fan perforation caused by HEI fragments also needs to be simulated. This could be done with the same test set-up as for the case of bleed duct perforation but with the temperatures and pressures adjusted.

The following data were also obtained from a P&WA F-100 engine performance deck for hot day installed conditions:

| Flight Condition | Fan Pressure (psia) | Fan Temperature ($^{o}R$) |
|---|---|---|
| T/O, Mach 0, Max Aug. Pwr. | 43 | 766 |
| S/L, Mach 1.2, Max. Aug. Pwr | 71 | 884 |
| 20K, Mach 0.8, Max. Continuous | 27 | 721 |

Data for all three types of damage are summarized on Table C-1. The conditions presumed to be most likely to support nacelle fires and most likely to tax the capability of a fire extinguishing system are identified. These are the basis for the revised Phase III AEN testing.

## C-4.0 Analysis of F-16 Nacelle Ventilation System Airflows

An analysis was made by W. H. Ball of the Boeing Military Airplane Company which provided estimates of the distribution of airflows in the aft engine bay of the F-16 aircraft for three flight conditions:

- o Mach 1.2, sea level dash
- o Mach 0.8, 35,000 feet cruise
- o Maximum afterburner power setting prior to start of take off roll

Airflows were determined for the basic configuration and a configuration with battle damage simulated by a 56.7 square inch hole in the nacelle outer wall. The results and assumptions used are discussed below.

A sketch of the basic geometry used in the flow analysis is shown in Figure C-1. It was assumed that the ram scoops (Ref. C-2) were located at Station 345, a distance 168.2 inches aft of the inlet lip. The geometry of the ram scoops is shown in Figure C-2 (Ref. C-3). The internal area distribution of the engine nacelle is shown in Figure C-3.

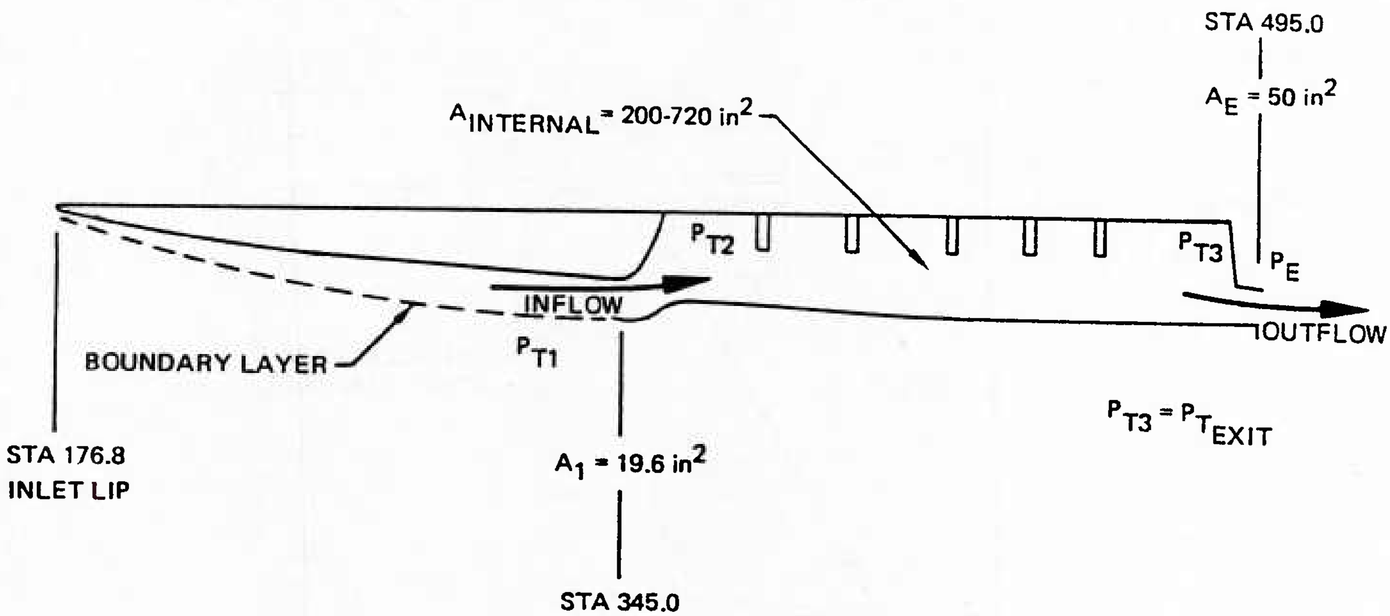



*Figure C-1. Sketch of Geometry Used in Analysis*

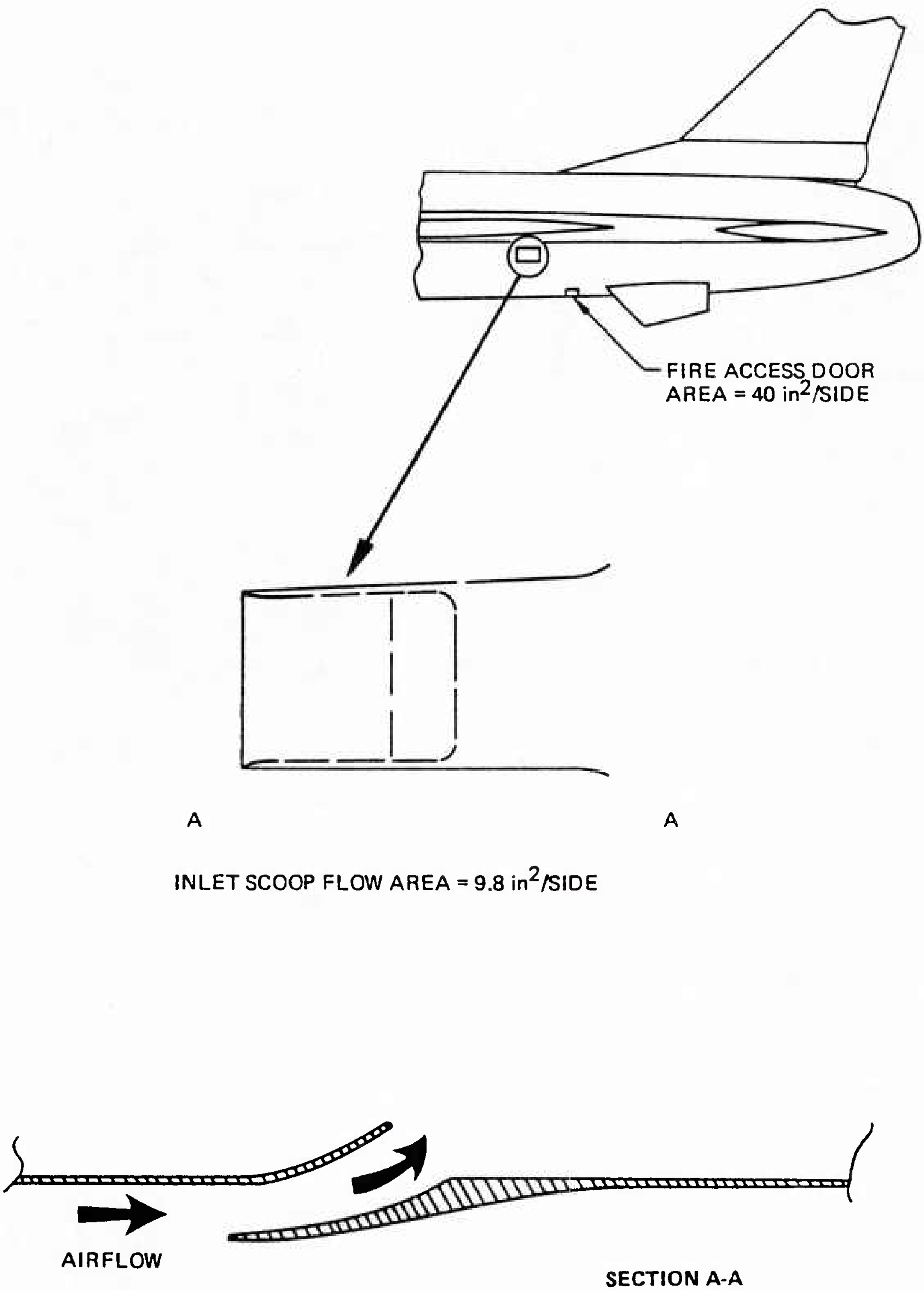



*Figure C-2. Nacelle Inlet Configurations*

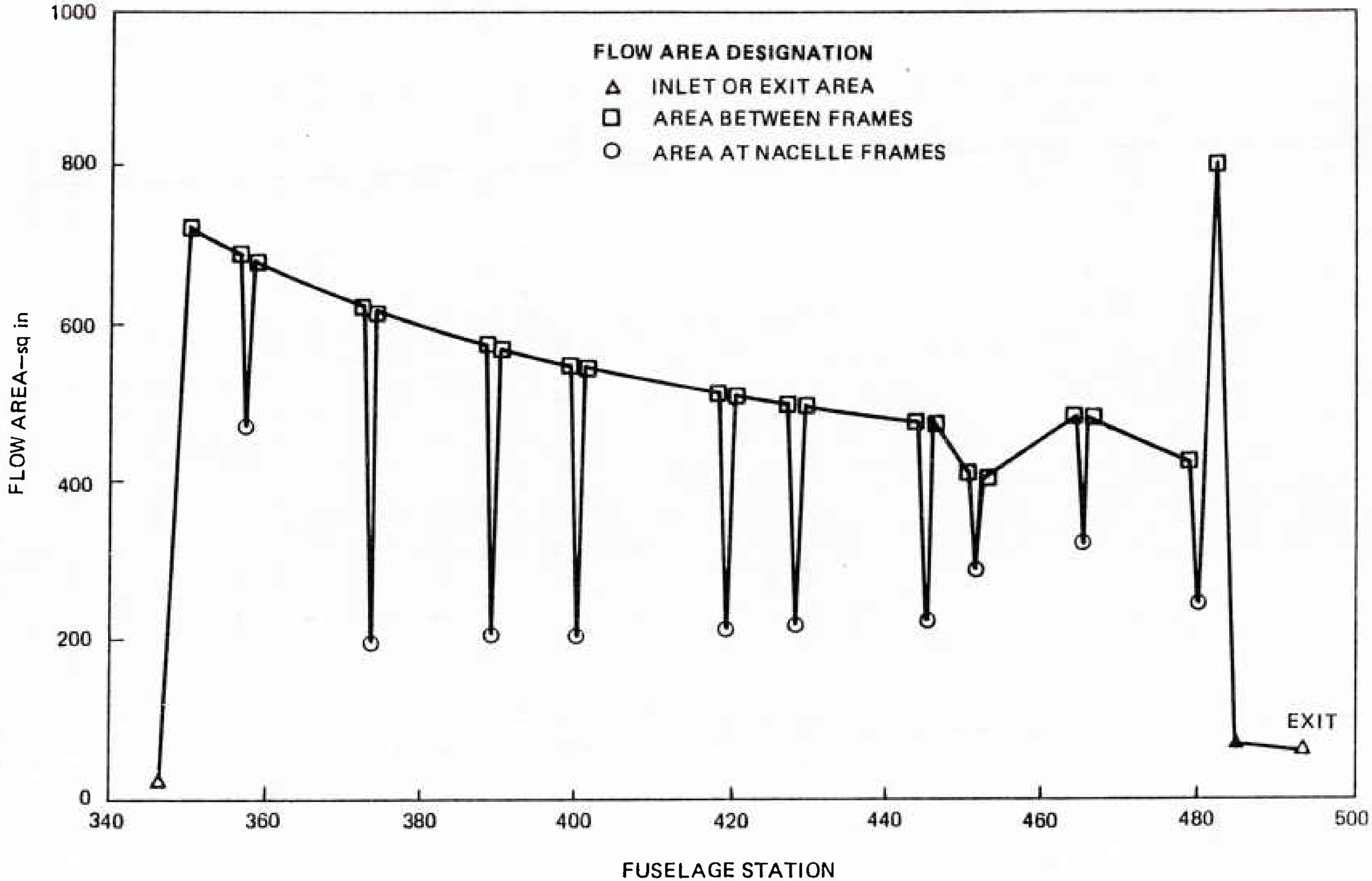



*Figure C-3. F-16 Nacelle Flow Area*

Prior to discussing the results it is convenient to define the notation used in subsequent discussions, i.e.,

Variables

$M$ = Mach number

$W$ = mass flow rate

$T$ = temperature

$P$ = pressure

$A$ = area

$r$ = scoop height

$\delta$ = boundary layer thickness

Subscripts

0 = free stream

1 = conditions at scoop entrance

2 = conditions just downstream of scoop entrance

3 = conditions just upstream of scoop exit

T = total or stagnation conditions

C-4.1 Mach 1.2, Sea Level Dash Case

To determine total pressure recovery of the ram scoop for the Mach 1.2 sea level dash, a calculation was made of the boundary layer thickness at the scoop station. For a Reynolds number of $8.5 \times 10^5$ per foot and a length of 168.2 in (14.02 ft.), the boundary layer thickness, $\delta$, was estimated to be 1.51 inches. For a scoop height, $r$, of 1.72 inches, the resulting $r/\delta$ ratio was 1.139. Using this ratio and data from Ref. C-4 (which provides inlet recovery as a function of $r/\delta$, free stream Mach number, and boundary layer profile parameter) the estimated inlet entrance total pressure recovery was 0.83 for a 1/7 power law profile.

To obtain the total pressure recovery at the forward end of the engine bay, dump losses were subtracted from the inlet entrance total pressure recovery. These dump losses are a function of the entrance mach number and the expansion ratio (Figure C-4). For the F-16 engine bay, the expansion ratio, $A_1/A_2$ = was .027. Using this expansion ratio, dump losses were estimated for a range

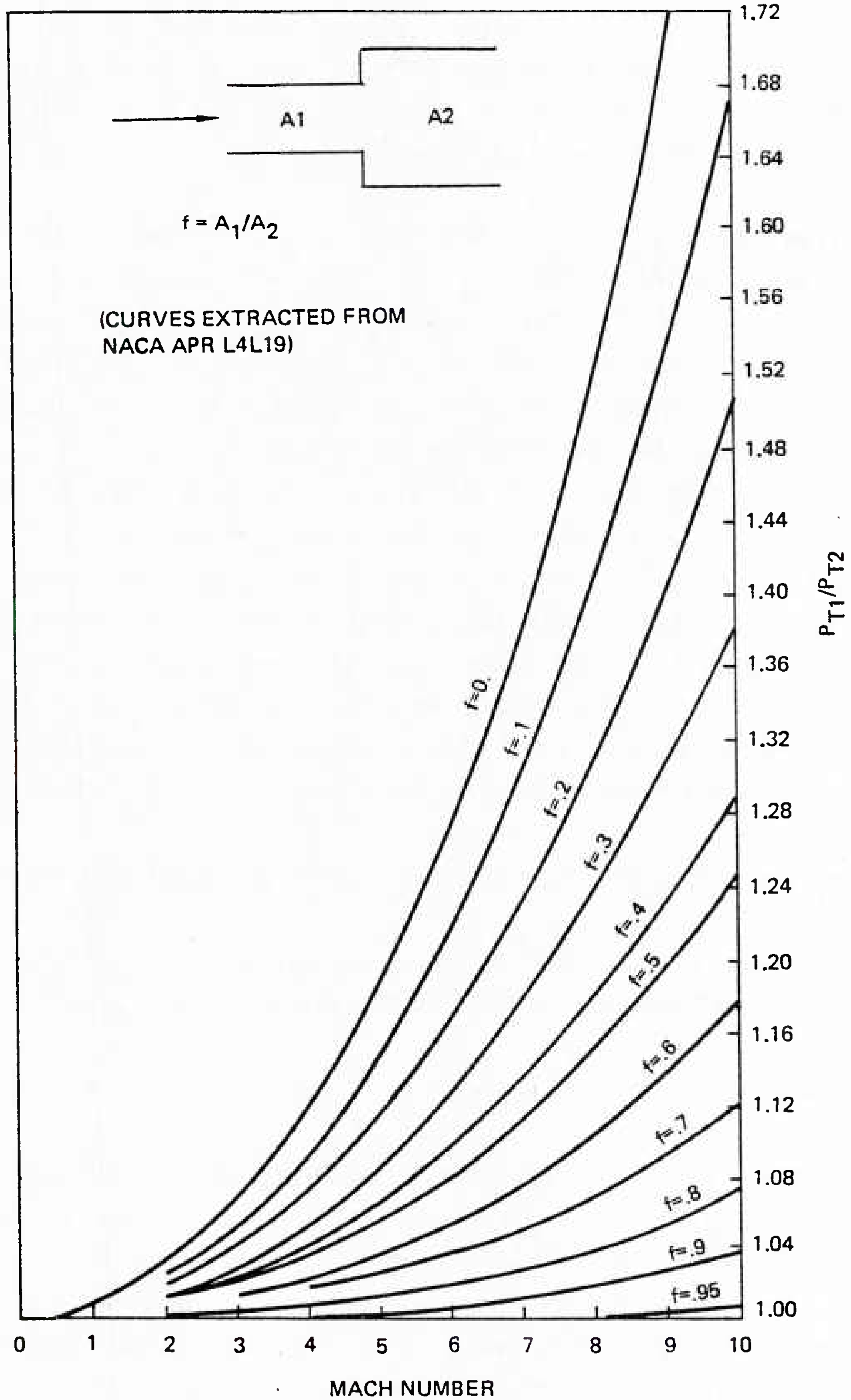



*Figure C-4. Sudden Expansion Loss Prediction Curves* of entrance mach numbers from .2 to 1.0. These dump losses were combined with the scoop inlet recovery to yield the inflow total pressure recovery at the upstream end of the engine bay, $P_{T2}/P_{T0}$, as a function of entrance Mach number, $M_1$. The corresponding inflows were calculated from the flow parameter, $W\ (T_T)^{.5}/AP_T$, as a function of $M_1$, using the corresponding $P_{T1}$, $T_{T1}$ ($=T_{T0}$), shown plotted in Figure C-5.

The outflow characteristics of the exits were estimated for a range of exit Mach numbers calculated from $P_{T3}$, and the exit static pressures shown in Figure C-6. The exit total pressure recovery ($P_{T3}/P_{T0}$) was estimated by multiplying the upstream total pressure recovery ($P_{T2}/P_{T0}$) by a factor of .95 to account for the total pressure losses through the engine bay. The velocities through the bay area are relatively low ($M$ = .03 - .09) and the pressure loss data contained in Ref. C-4 indicate that a total loss of $\Delta P/P_{T2}$ = -.05 is a reasonable approximation for the losses. The exit mass flow parameter, $W\ (T_T)^{.5}/AP_T$, was then used with the exit total pressure, total temperature, and area to obtain the corresponding exit mass flow as a function of engine bay total pressure recovery. The plotted data for outflow results (Figure C-5) were used to obtain the matched operating point. As shown on Figure C-5, the operating point for scoop inflow is at a bay total pressure recovery of 0.44 and a mass flow of 11.9 lbm/sec.

Two other cases were studied for the $M_0$ = 1.2, sea level dash condition:

1. A flush "flower" hole in the engine bay wall.
2. A "scoop" type flower hole in the engine bay wall.

These configurations are illustrated in Figure C-7.

For the flush hole, the engine bay total pressure recovery, $P_{T2}/P_{T0}$, was equal to 0.44. It was assumed that the external flow was at free-stream static pressure, $P_0/P_{T0}$ = .4214. Thus, the pressure differential to cause outflow from inside the engine bay was small. However, the shock system associated with the outflow would cause the external pressure to rise to a value equal to or greater than the internal pressure, which would cause the outflow to cease. In reality, a small amount of flow would exit, causing a weak shock system to form and increasing the external pressure to a value

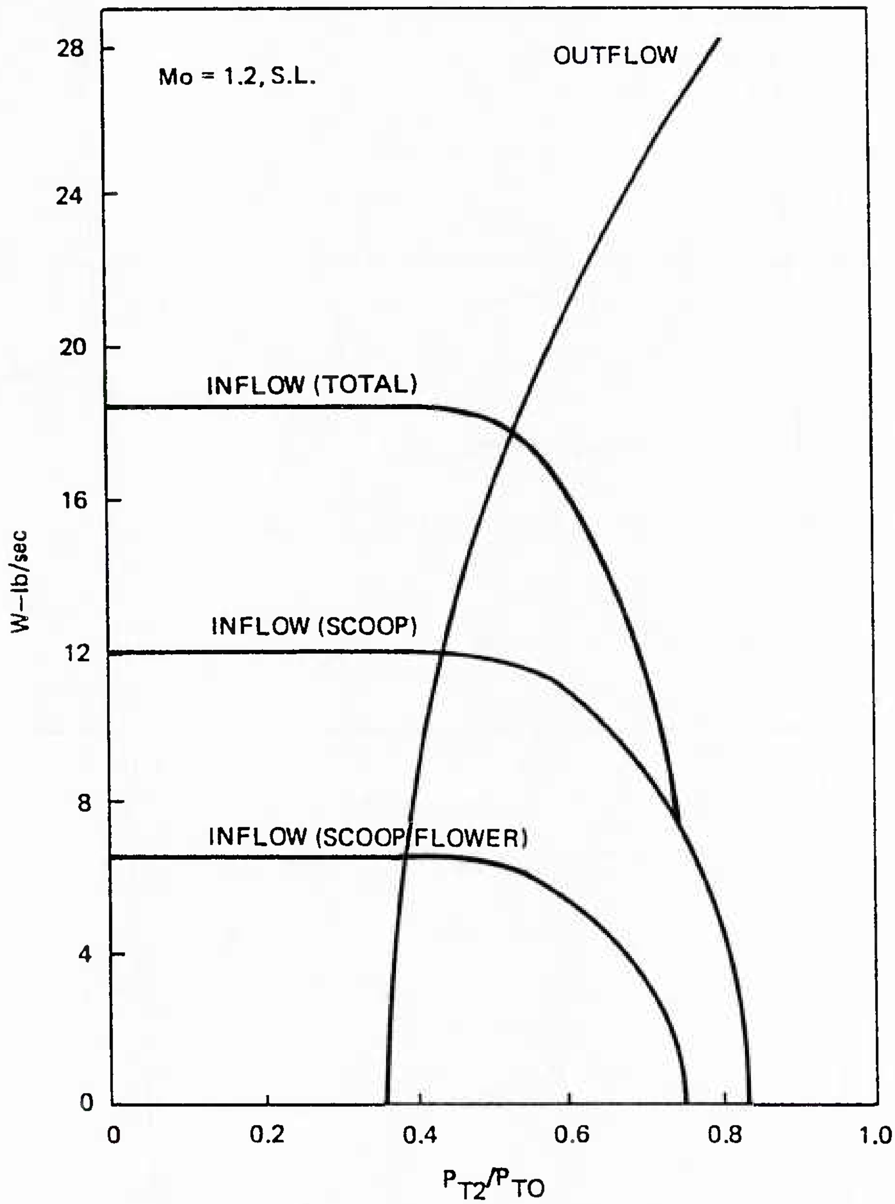



*Figure C-5. Inflow/Outflow Matching Curves for Mo = 1.2, S.L.*

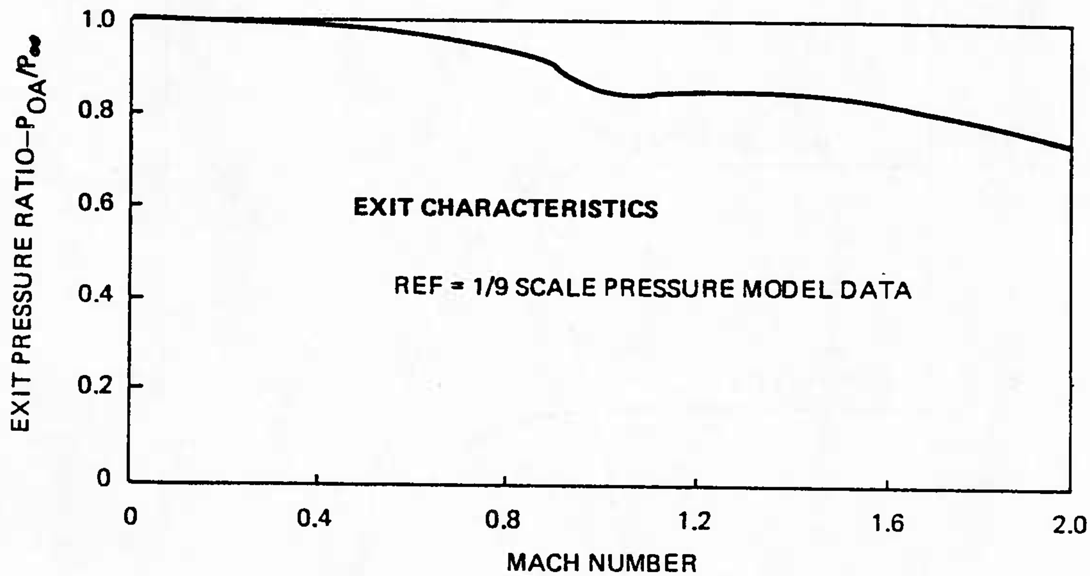
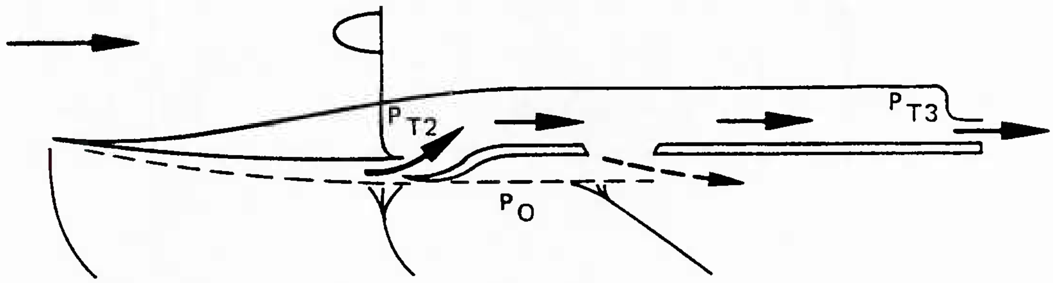
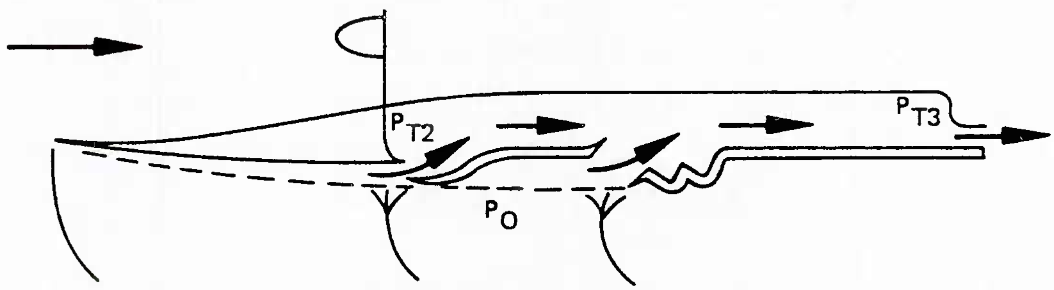



*Figure C-6. Nacelle Exit Characteristics*




(a) Flush Hole




(b) "Scoop" Type Hole

*Figure C-7. HEI "Flower" Damage Flow Models for Mo = 1.20, S.L.*

approximately half way between the external and internal pressure. Experience from previous inlet sideplate spillage analyses has shown that the exit flow from such a hole is discharged at an angle equal to 1/2 the expansion angle required to expand the internal flow to the external pressure. For the $M_0$ = 1.2 case, with both pressures nearly equal, this angle is calculated to be $.6^0$. For this flow angle, the amount of outflow that can be expected is only .064 lbm/sec.

In the case of the flower "scoop", it was assumed that the scoop had an entrance area equal to 60% of the ram scoop area (0.60 x 19.6 - 11.76 in$^2$). It was also assumed that the total pressure recovery of the flower scoop was .90 of the recovery of the ram scoop. Using a procedure similar to that previously described for the ram scoop, the inflow characteristics for the flower scoop were calculated to be as shown in the plot of Figure C-5. With the increased inflow of the flower scoop, the match point with the outflow would be at an increased total mass flow of 17.7 lbm/sec and a bay total pressure recovery, $P_{T2}/P_{T0}$ = 0.54 ($P_{T2}$ = 19.25 psia).

## C-4.2 Mach 0.8, 35,000 ft Cruise Case

A similar inflow/outflow matching procedure was used for the $M_0$ = .80 case. The boundary layer thickness at the ram scoop location was calculated to be 2.03 in. based on a Reynolds number per foot of 1.96 x $10^6$. Thus, the ratio of ram scoop height to boundary layer thickness used with Reference C-4 to obtain scoop total pressure recovery was $r/\delta$ = .85. The corresponding inlet recovery was 0.90. Adding the dump losses to this recovery and matching with the outflow characteristics for $M_0$ = .80 provided the flow matching data presented in Figure C-8. The operating point is at a bay pressure recovery, $P_{T2}/P_{T0}$ = .69 and a mass flow of 2 lbm/sec.

The two cases of a flush flower hole and a scoop type flower hole were also analyzed for Mach 0.8 flight at 35,000 feet. The results are described below.

In the case of the flush flower hole, the internal bay pressure recovery is $P_{T2}/P_{T0}$ = 0.69. The external pressure, $P_0/P_{T0}$ = .656.

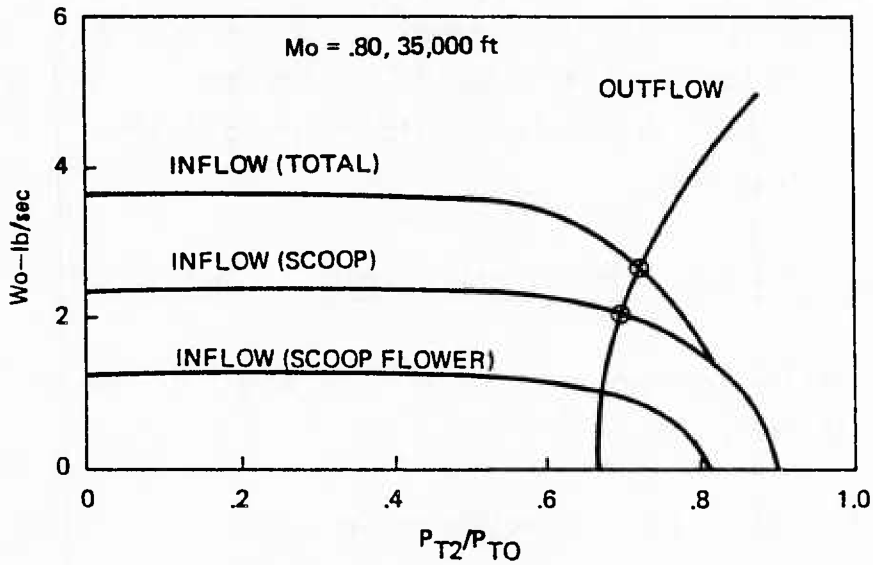



*Figure C-8. Inflow/Outflow Matching Curves for Mo = 0.80, 35,000 ft*

Therefore, some outflow can be expected. Using the available pressure differential and known hole area (56.7 $in^2$), the maximum mass flow through the hole with no external flow was calculated. However, the presence of external flow would strongly affect the flow through the hole. As a first approximation to include the effect of external flow, an interpolation was performed (Figure C-9) to estimate the outflow. The predicted outflow was .82 lbm/sec, 41% of the original flow through the bay without the flush hole.

In the case of the flower "scoop", it was again assumed that the flower scoop recovery was 0.90 of the recovery of the ram scoop. From inflow/outflow matching (Figure C-8), the flower scoop was estimated to increase the total airflow from 2 lb/sec to 2.8 lb/sec. The bay total pressure increased to $P_{T2}/P_{TO}$ = .72. Thus, the ratio of flower scoop inflow to inflow without the flower scoop was 0.41.

C-4.3 Maximum After Burner Power Setting Prior to Takeoff Roll

The aft bay airflows and pressure differences obtained from Ref. C-2 were used to analyze this case, The data are:

| | | |
|---|---|---|
| $\Delta P_T/P_{TO}$ for inlets (total, including fire doors) | = | 0.0025 |
| $W\ (T_T)^{.5}/P_T$, lbm/min | = | 282. |
| W, lbm/min | = | 177.6 |

For the total inlet area of 99.6 $in^2$ (2 scoops of 9.8 $in^2$ each plus 2 fire doors of 40 $in^2$ each), and a total airflow of 2.96 lbm/sec, the average Mach number at the inlet ports was approximately .052. Since this entrance Mach number was low, the dump loss into aft bay was very small ($\Delta P_T/P_{TO} \simeq$ .0025). Therefore, the engine bay recovery was approximately .9975, and the engine bay pressure was only slightly lower than the external pressure. A wound in the nacelle wall of 56.7 $in^2$ would have a negligible effect on airflow or total pressure recovery. It would however, alter the distribtuion of flow quantity and velocity upstream of the flower hole. The flow velocity upstream of the flower hole could be reduced to as low as 5 ft/sec.

Table C-2 summarizes the estimated aft engine bay airflows for the three flight conditions analyzed.

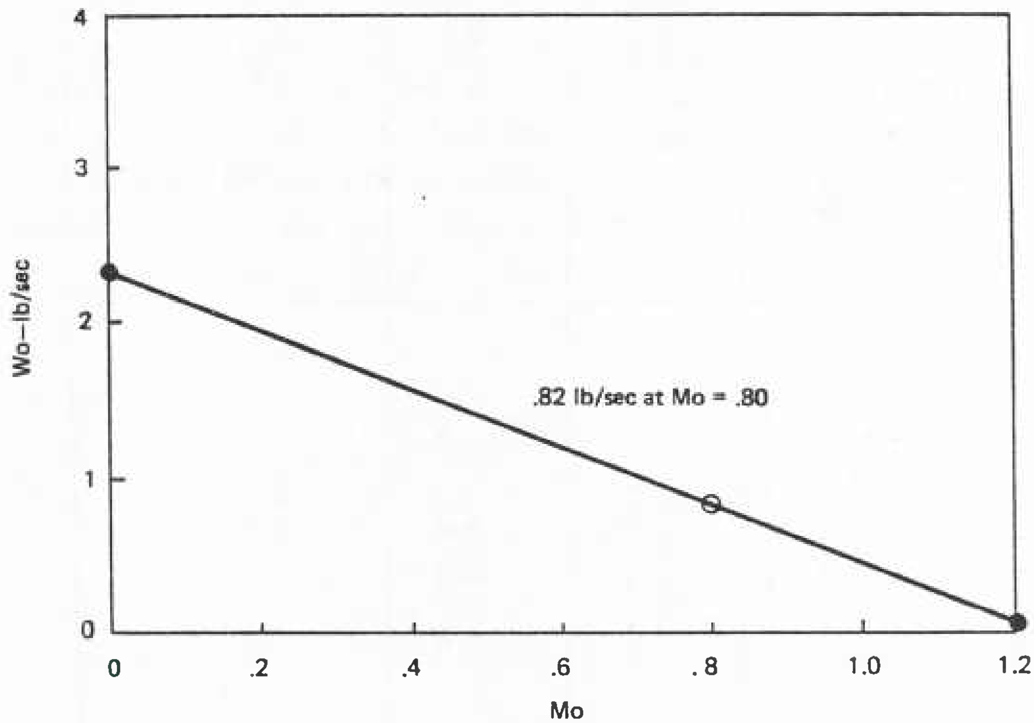



*Figure C-9. Interpolation Curve for Estimating Outflow Through "Flower" at Mo = 0.80, 35,000 ft*

## TABLE C-2

SUMMARY OF AFT BAY AIRFLOWS

| FLIGHT CONDITION | TOTAL AIRFLOW THROUGH AFT ENGINE BAY WITHOUT FLOWER | TOTAL AIRFLOW THROUGH AFT ENGINE BAY WITH FLUSH FLOWER HOLE | TOTAL AIRFLOW THROUGH AFT ENGINE BAY WITH "SCOOP" FLOWER HOLE |
|---|---|---|---|
| $M_o$ = 1.2<br>S.L. Dash | 11.9 pps | 11.84 pps<br>.06 pps Outflow | 17.7 pps<br>5.8 pps Inflow |
| $M_o$ = .80<br>35000 ft Cruise | 2.05 pps | 1.23 pps<br>.82 pps Outflow | 2.80 pps<br>.75 pps Inflow |
| $M_o$ = 0.0<br>Max A/B<br>(Prior to T/O) | 2.96 pps | 2.96 pps<br>Up to 36 % Outflow | 2.96 pps<br>Up to 35 % Inflow |

## REFERENCES

C-1 Gandee, G. W., Private Communication

C-2. Zielka, D. G., "Flight Test Report on F-16 Nacelle Ventilation System," 16PR1244, General Dynamics, 30 July 1979.

C-3. Section 5, "Fire Protection and Nacelle Ventilation," from YF-16 proposal.

C-4. Simon, P. C., and Kowalski, K. L., "Charts of Boundary- Layer Mass Flow and Momentum for Inlet Performnace Analysis, Mach number Range 0.2 to 5.0," NACA TN 3583, November 1955.

## APPENDIX D
## AEN DATA REDUCTION EQUATIONS

The following two sections provide the equations used to calculate ventilation airflows and velocities for the 8-inch, 24-inch and sonic nozzles used to measure simulated bleed airflow.

### D-1 Derivation of Venturi Mass Flow Rate and Velocity Equations

As stated in Reference D-1, the mass flow through a venturi meter, in lbm/sec, is equal to:

$$W = Cd * A2 \sqrt{\frac{2 \; g_c \; \rho \; \Delta P}{1 - \beta^4}} \sqrt{\frac{r^{2/k} \; (k) \; (1-r^{(k-1)k}) \; (1-\beta^4)}{(k-1) \; (1-r) \; (1-r^{2/k} * \beta^4)}} \qquad \text{(D1)}$$

The first radical term is the incompressible flow equation and the second radical term is the compressibility correction.

where:

| | |
|---|---|
| $W$ | = air mass flow rate in lbm/sec |
| $A2$ | = throat cross sectional, $in^2$ |
| $Cd$ | = discharge coefficient |
| $g_c$ | = gravitational conversion factor 32.2 $\frac{lbm\ ft}{lbf\ S^2}$ |
| $\rho$ | = upstream air density $lbm/ft^3$ |
| $\Delta P$ | = differential pressure across venturi, P1-P2, psig |
| P1, P2 | = inlet and outlet pressures, psig |
| $\beta$ | = ratio of throat diameter to upstream inlet pipe diameter, D2/D1 |
| D1, D2 | = inlet and throat diameters, respectively, in inches |
| $k$ | = specific heat ratio |
| $r$ | = ratio of outlet to inlet pressure, P2/P1 |

For air (k = 1.4) this simplifies to:

$$W = .525\ Cd\ D2^2 \sqrt{\rho \quad \Delta P} \sqrt{\frac{r^{1.429} \ (3.5)\ (1-r^{.2857})}{(1-r)\ (1-r^{1.429} * \beta^4)}} \qquad (D2)$$

Using the ideal Gas Law to evaluate the air density:

$$\rho = \frac{P1 \quad 144.}{R \quad Tv} \qquad (D3)$$

where:

R = gas constant for air, 53.35 (ft lbf)/(lbm $^{O}$R)

Tv = venturi air temperature, $^{O}$R

substituting equation (D3) into (D2) and simplifying:

$$W = 1.614\ Cd\ D2^2 \sqrt{\frac{P1\ \Delta P\ r^{1.429}\ (1-r^{.2857})}{Tv\ (1-r)\ (1-r^{1.429}\ \beta^4)}} \qquad (D4)$$

The air velocity in the test section is:

$$V = \frac{W}{\rho\ A} \qquad (D5)$$

where:

V = clean test section velocity in ft/sec

A = clean test cross-sectional area in ft$^2$

Substituting equation (D3) into equation (D5) and simplifying:

$$V = \frac{.152\ W\ Tv}{PT} \qquad (6)$$

where:

PT = pressure in test section, in psia

The flow parameters of the 8-inch and 24-inch nozzles used for substitution into equation (D4) are as follows:

| Nozzle | $C_d$ | $D_2$ | $\beta$ |
|---|---|---|---|
| 8-inch | .985 | 4.1768 | .4968 |
| 24-inch | .9895 | 10.158 | .4277 |

D-2.0 Calculation of Bleed Air Mass Flow Rate

Fliegner's formula for sonic flow through a choked orifice or nozzle states (Reference D-2):

$$W = \frac{.532\ A^*\ P1}{(T_1)^{1/2}} \tag{D7}$$

where

$A^*$ = effective throat area = .069 square inch according to manufacturers specifications

$T_1$ = Inlet Temperature

Equation (D7) simplifies to:

$$W = \frac{.03671\ P1}{(T1)^{1/2}} \tag{D8}$$

## REFERENCES


D-1 Kunkle, J. S., et al., "Compressed Gas Handbook," NASA GSP-3045, 1969.

D-2 Shapiro, A. H., "The Dynamics and Thermodynamics of Compressible Fluid Flow," VOL 1, Ronald Press, New York, 1953

APPENDIX E

# DISPOSITION OF TAB DATA, VIDEO TAPES, TEST LOGS AND HALON CONCENTRATION PLOTS

## E-1. Test Run Logs

Run logs were recorded for every test condition including the pitot probe calibrations, the fire tests and the Halon concentration measurement tests. The original copies are currently on file in the AEN test office at WPAFB. These logs note the ventilation airflow conditions, the Halon charge, as measured in the sight gauge, the nitrogen back charge pressure and, in the case of fire tests, whether knockdown was achieved and if a video tape was made of the test. Additional copies can be made available upon request.

## E-2. Video Tape Recordings

As previously noted the video tape records of the fire test are incomplete and of mediocre quality because of problems with both the camera and the VTR. The tapes that were acquired are also on file in the AEN test office. They could be of some help in interpreting the events which occurred although the colors are rarely believable.

## E-3. Tab Data

Conflict with concurrent testing in the Simulated Aircraft Fuel Tank Environment (SAFTE), precluded use of the ModComp disks to record AEN data, except in the case of the Halon concentration calibrations where this was necessary to allow off-line processing. Copies of the basic AEN tab data for fire tests and Halon concentration tests and of tab data records of the Halon concentration measurements are also on file in the AEN test office.

## E-4. Halon Concentration Plots

Halon concentration data were recorded on disk by the ModComp computer for off-line plotting. Magnetic tape records of these data have been prepared for use when a more accurate method of computer enhancement is available.

Plots of Halon concentration versus time have been made of all the Halon concentration measurement test conditions using the ModComp flat bed plotter. A complete set of plots are available in the AEN test office, of these data as acquired and as enhanced using the technique described in Appendix F.

As a more accurate means of enhancement becomes available, it is anticipated that these data will be presented in subsequent reports.

# APPENDIX F
# RESPONSE ENHANCEMENT FOR HALON CONCENTRATION MEASUREMENT

## F.1 PROCEDURE AND RESULTS

Beckman LB-2 gas analyzers (Halonizers) were used in the AEN to measure the concentration of halon extinguishing agent in the test section during halon dumps simulating aircraft nacelle fire extinguishant release events. Six channels of this Beckman equipment were normally used, (Figure F-1). Halon concentration was recorded by the facility ModComp computer at 100 samples per second so that 193 $\pm$ 2 halon measurements were recorded during a typical two-second dump event. These data were stored on disc for subsequent off-line plotting as well as being output on the facility line printer following each test condition.

Overall system accuracy was repeatedly checked using a 7% halon 1301 calibration mixture. As long as the optical balance units on the pickup heads were adjusted weekly and the span settings were adjusted on a daily basis, in accordance with the instructions in the Beckman Operation and Maintenance manual for these units, the accuracy was found to be about $\pm$ 0.2% (by volume) for the 1% to 10% concentrations (by volume) normally encountered. The reponse time of the Halonizers was approximately 200 ms and is faster than most halon measuring instruments available.

However, because many of the test halon dumps of interest were found to consist of very short pulses of between 150 ms and 300 ms, it was suspected that accurate peak concentrations could not be measured by this equipment without some sort of computer enchancement of the data. A halon pulse simulator was constructed using a three-way solenoid valve (Figure F-2). It was confirmed using this simulator that peak concentrations could be 10% to 30% low for pulses in the 150 ms to 200 ms range.

Additional data acquired using the halon pulse simulator which were employed to develop a computer enchancement technique which uses this equation:

$$Y_n = 7.3y_{n+1} - 6.3y_n \qquad (1)$$

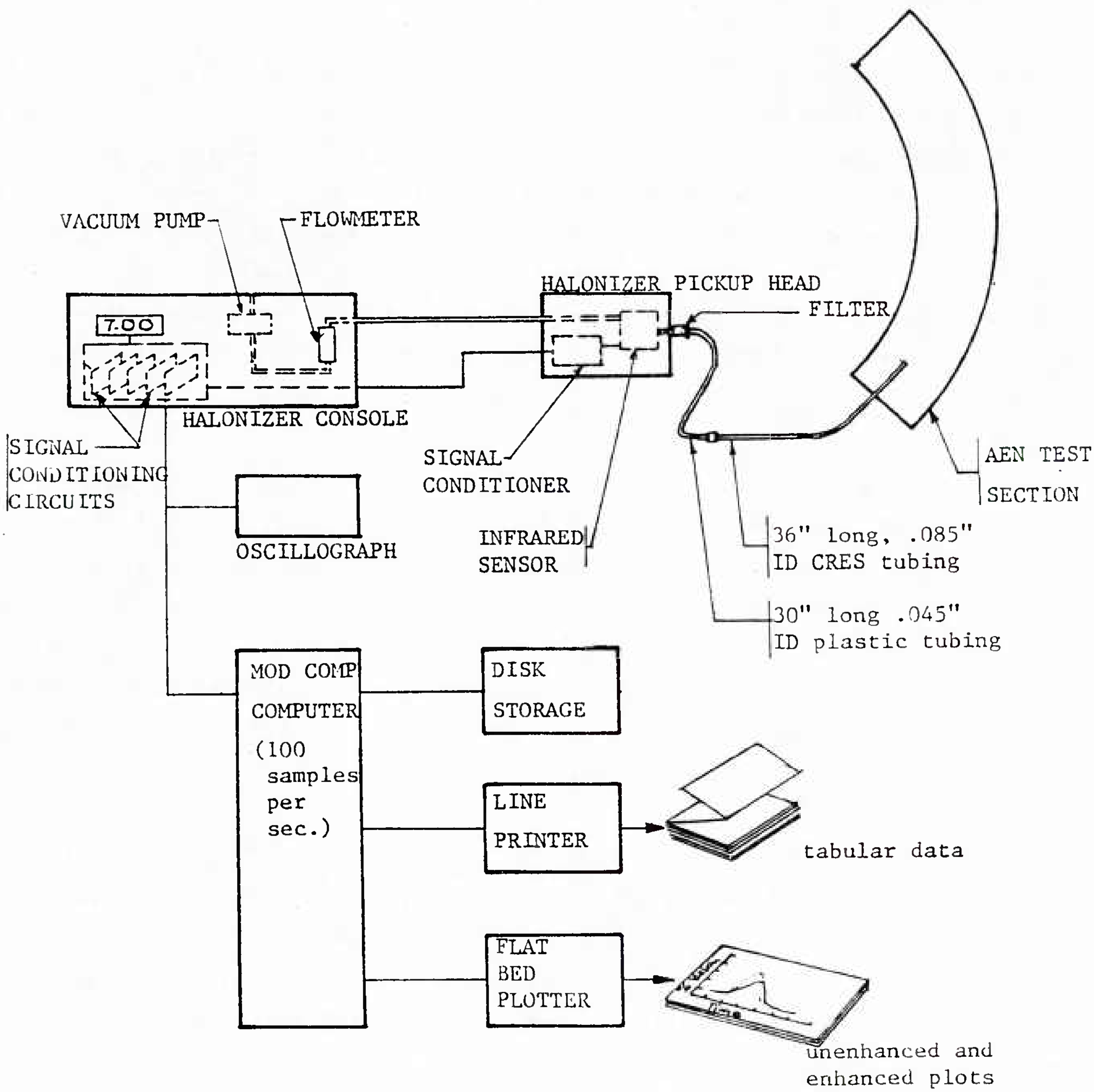



*Figure F-1. System Diagram for Halon Concentration Measurement in the AEN*

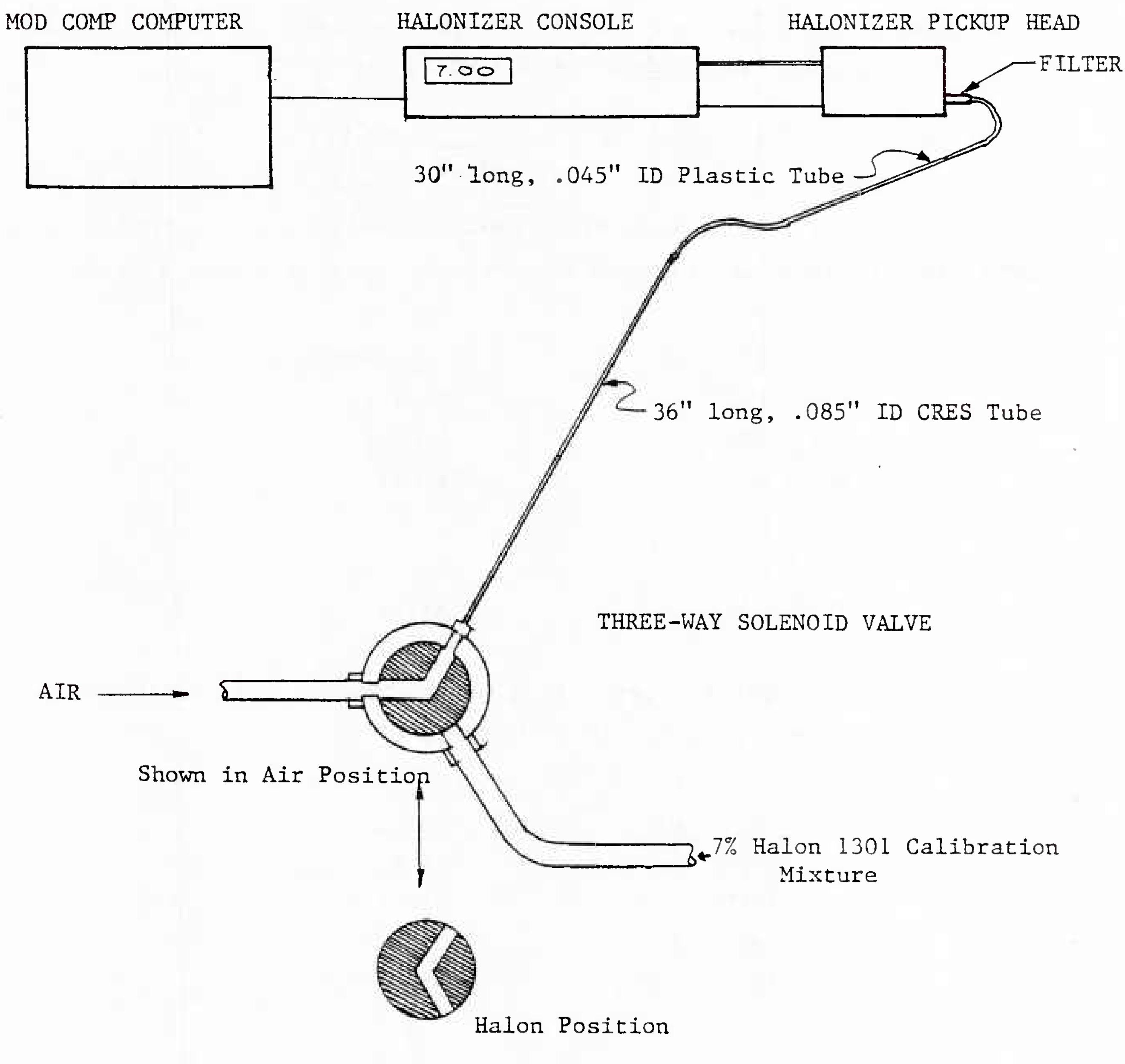



*Figure F-2. Halon Pulse Simulator With Three-Way Solenoid* where: $Y_n$ = YDATA1 = enchanced % Halon

$y$ = YDATA = measured % Halon

$n$ = nth reading

In actual use, this was simply a correction applied to each halon concentration measurement based on the magnitude of it and of the next following measurement. For example, if a concentration of 4.5% was measured at a time of 0.49 seconds and if 5% was measured at 0.50 seconds, the corrected concentration for 0.49 seconds would have been:

$$Y_{(.49)} = 7.3(5.0) - 6.3(4.5) = 8.14\%$$

During the acquisition of test data, the computer program acquired an array of about 193 concentrations and time measurements and stored them on disc:

| % Halon Concentration | Time in Seconds |
|---|---|
| YDATA (001) | X(001) |
| YDATA (002) | X(002) |
| YDATA (003) | X(003) |
| . | . |
| . | . |
| YDATA (193) | X(193) |

During off-line processing prior to plotting, each concentration measurement was enchanced using equation 1 to build a new array:

| Enhanced % Halon Concentration | Time in Seconds |
|---|---|
| YDATA1 (001) | X(001) |
| YDATA1 (002) | X(002) |
| YDATA1 (003) | X(003) |
| . | . |
| . | . |
| YDATA1 (192) | X(192) |

(The last value was dropped because there was no subsequent value to use in the enchancement).

A plot was prepared from data acquired with the Halon pulse simulator showing both the original Halon concentration measurements and the enhanced data using the enhancement equation (Figure F-3). The Halon pulse, in this case, was a step change from zero to 7 percent. The data enhancement function was quite sensitive to any "noise" in the data and produced a completely meaningless enhancement curve if the original data was erratic. Even with relatively smooth data such as shown in Figure F-3, the enhanced curve tended to wander up and down within $\pm 0.1$ to 0.2%. The average concentrations for the enhanced and measured data agreed exactly, but the enhanced data indicate peak measurements 0.2% higher.

A similar data plot for a 0.05 second pulse was made (Figure F-4). In this case, the enchanced data showed a single peak looking very much like the "noise" shown on Figure F-3. A more accurate peak level, judging from the enchanced data from Figure F-3, would have been to exclude the single value peak and take the next data value below it as the peak value.

The actual computer program used and the mathematical derivation of this function are also included in Section F.3. The accuracy of peak concentration data, both with and without this enhancement, is shown on Figure F-5 for the test data acquired with the three-way solenoid valve. The percent increase in concentration which results from application of the enhancement to these data is shown in Figure F-6.

A second, somewhat faster Halon pulse simulator was constructed to test the validity of this correction using the method illustrated in Figure F-7. The Halon probe was physically shifted the one half-inch from a jet of air to a jet of 7% Halon in about 15 ms. This input signal was effectively a square wave of 7% Halon. The solenoid was controlled by a pulse timer to provide 7% pulses ranging from 50 ms to 1000 ms duration. ModComp data were recorded, again at 100 samples per second, during all test conditions.

A sample plot of these data was made with the original Halon concentration, as measured by the Beckman equipment, and with the computer enchanced Halon concentration also shown (Figure F-8). Data from all these test Halon pulses is summarized in Figure F-9. A significant improvement in measurement accuracy was seen as the pulse duration decreases.

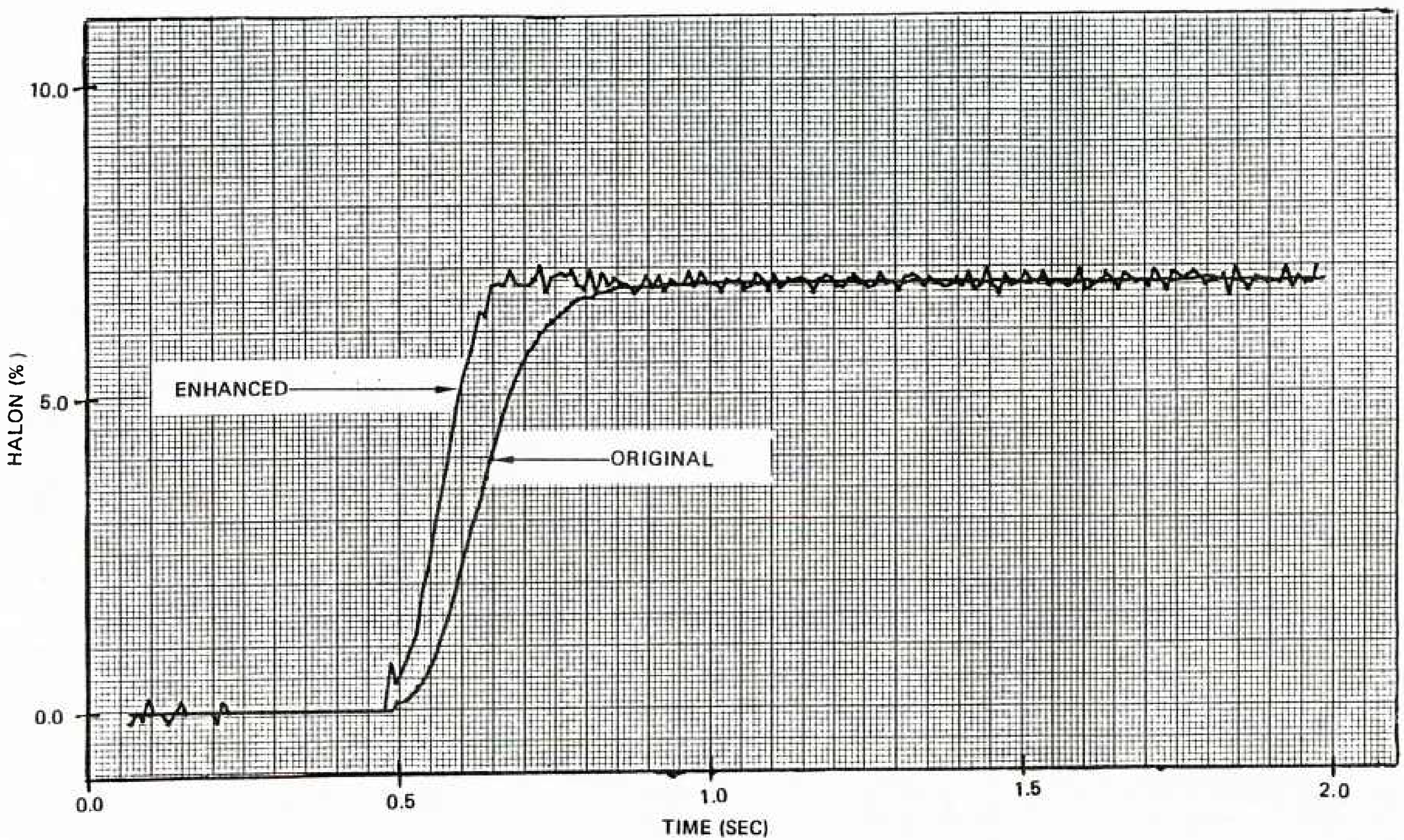



*Figure F-3. Response Enhancement for Halon Concentration Input of Step Change*

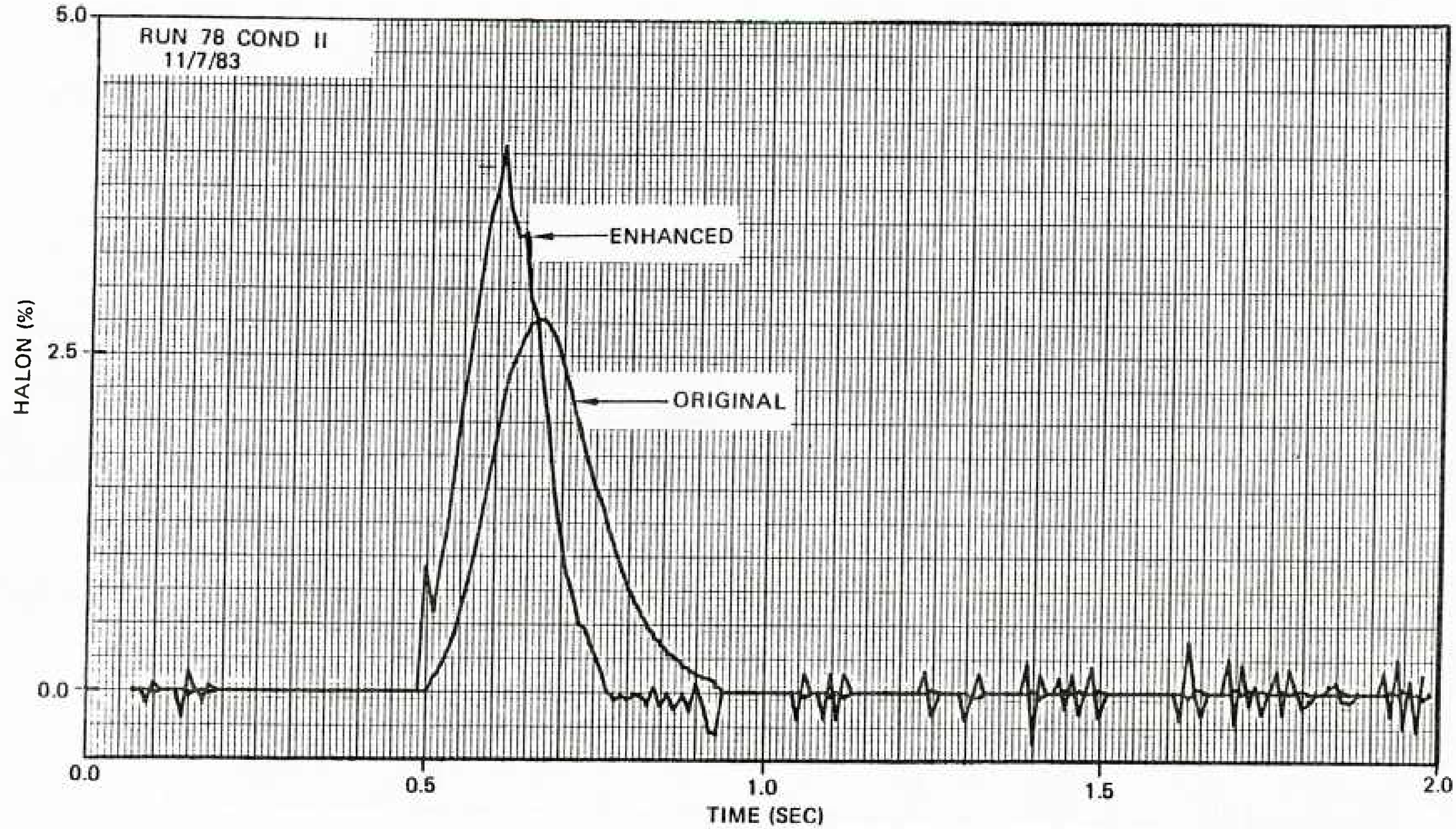



*Figure F-4. Response Enhancement for Halon Concentration Input of 0.05 Sec. Duration Pulse*

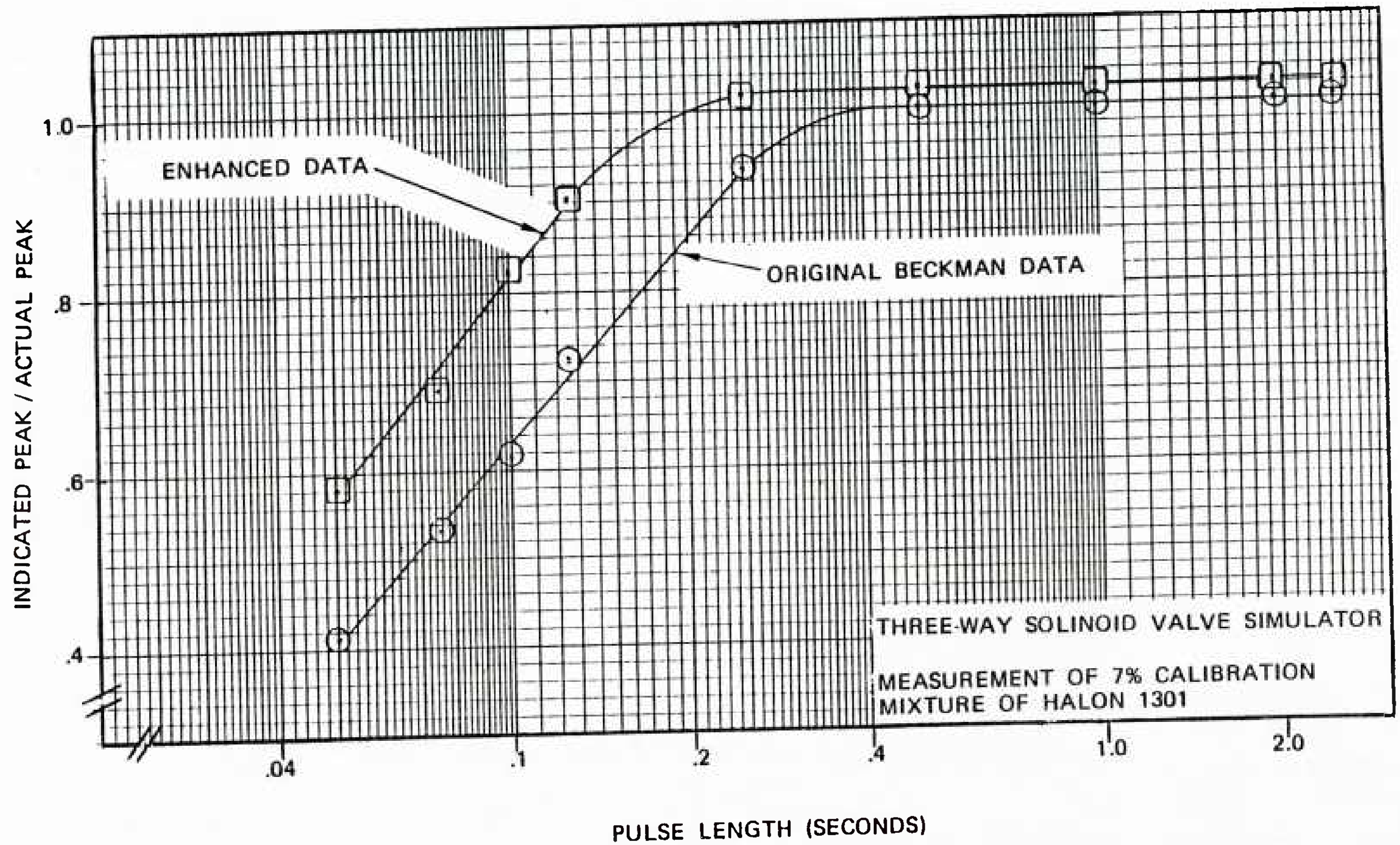



*Figure F-5. Ratio of Indicated to Actual Halon Peak Concentration Measurements for Various Length Pulses*

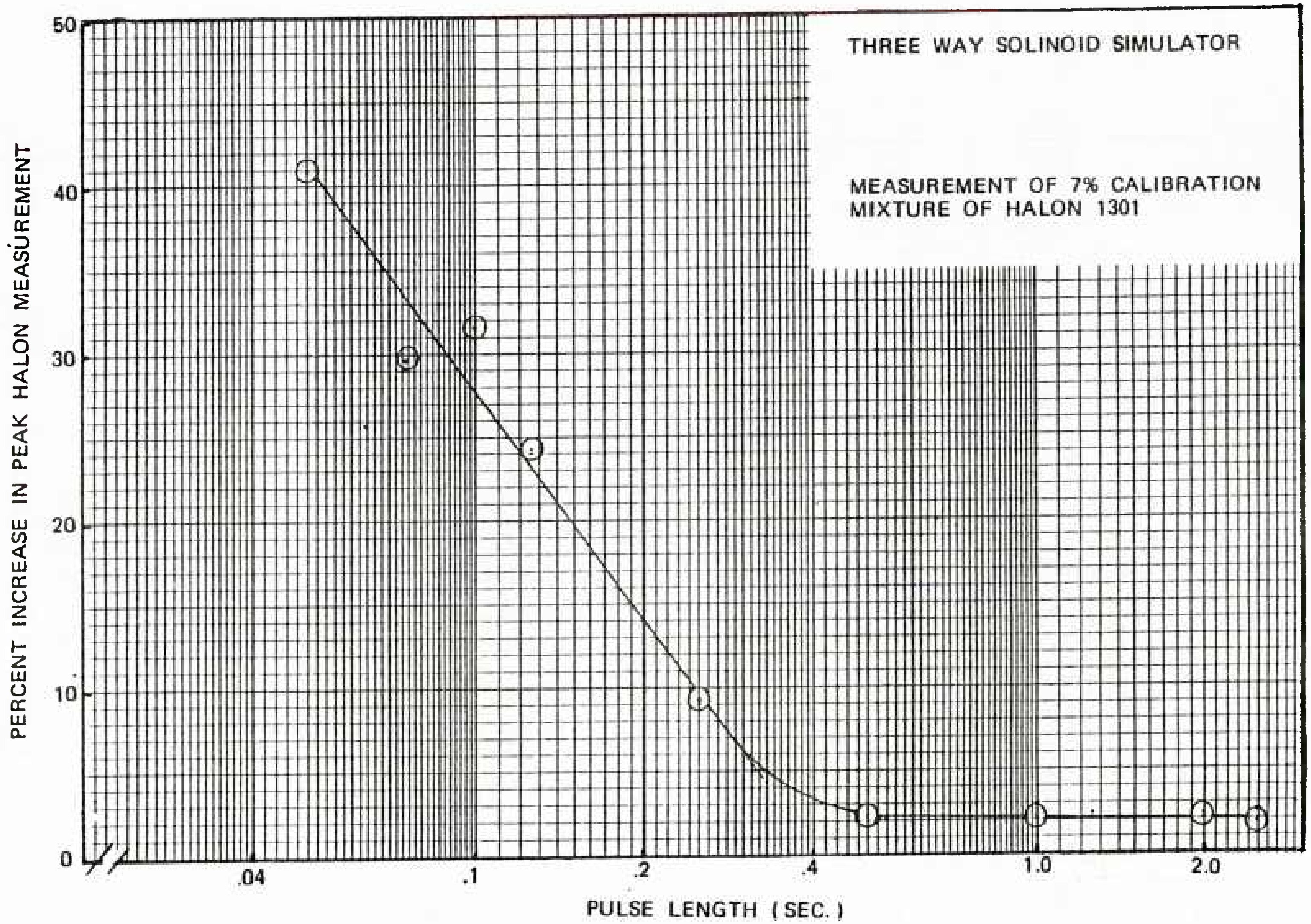



*Figure F-6. Percent Increase in Peak Halon Concentration Measurements Due to Enhancement*

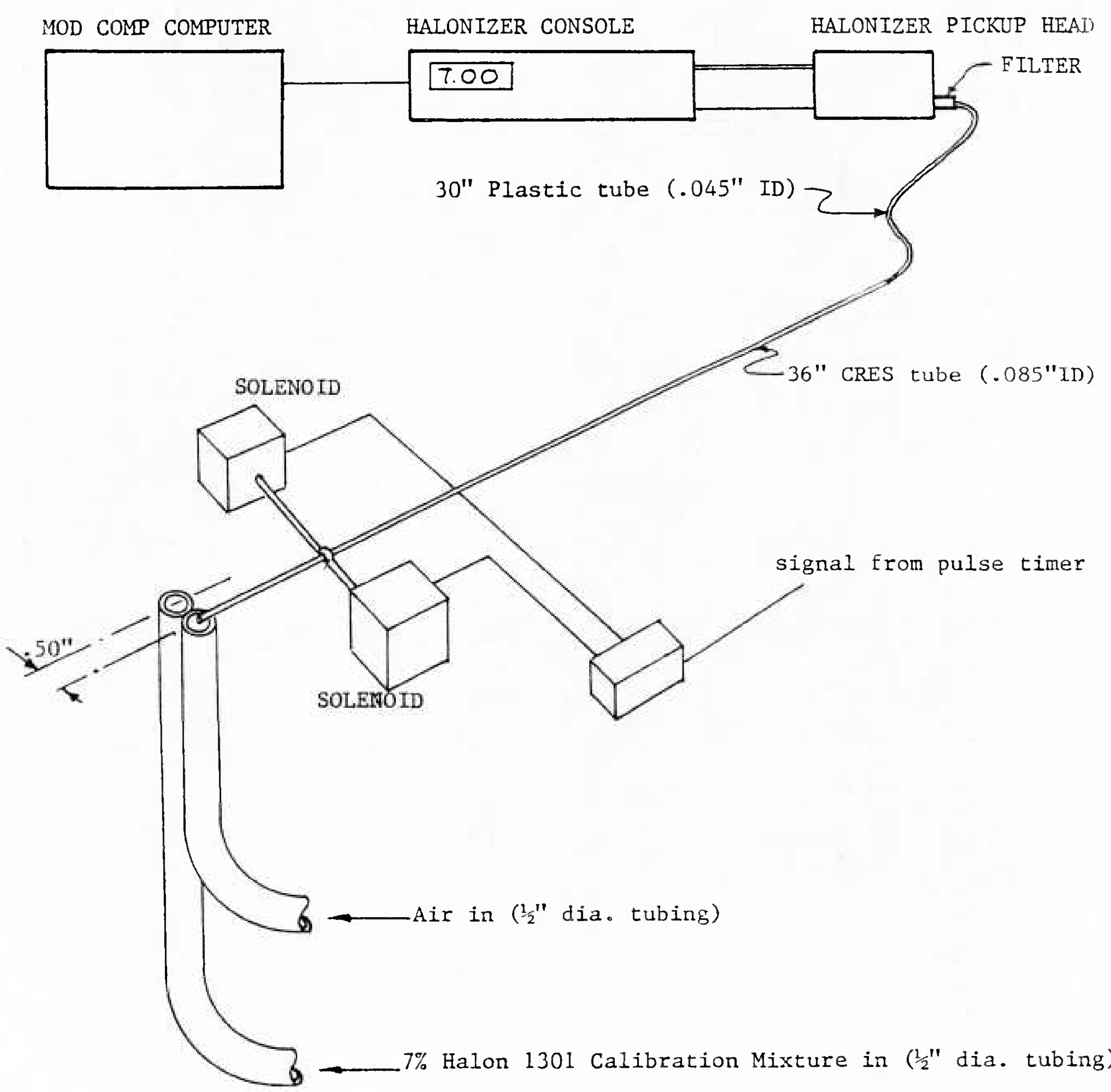



*Figure F-7. "Square Halon Pulse" Simulator*

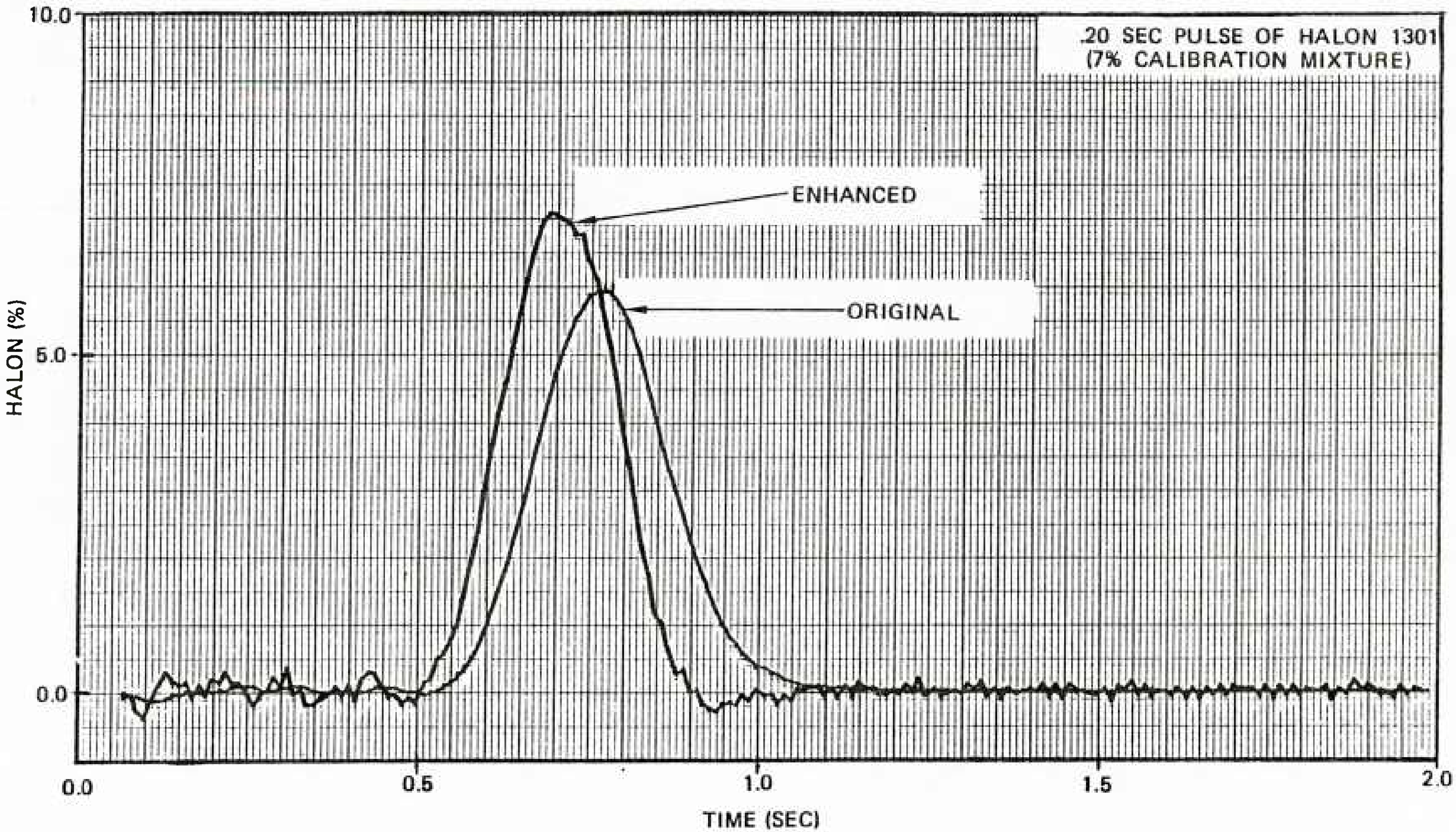



*Figure F-8. Sample Data Plot From "Square Halon Pulse" Simulator Data with Enhancement*

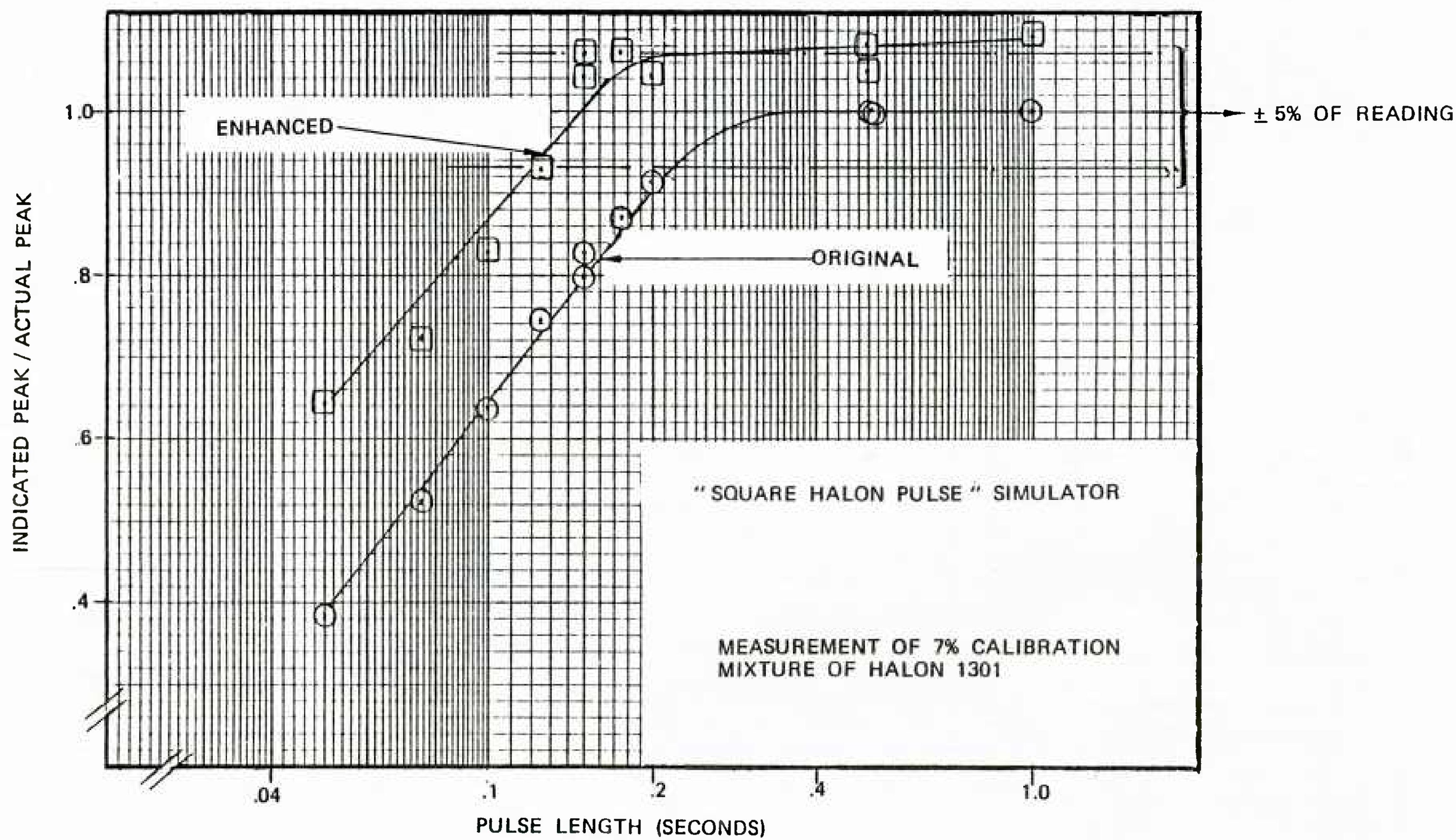



*Figure F-9. Ratio of Indicated to Actual Halon Peak Concentration Measurements Using "Square Halon Pulse" Simulator*

The tendency of the enhanced data to oscillate, even when a steady peak level was reached by the measured data, tended to cause a small positive error in the enhancement, particularly with the longer duration pulses, as shown in Figure F-9. Despite this, the enhanced data was much more accurate in the range of greatest applicability to current AEN testing, 150 ms to 300 ms. For any pulse greater than 150 ms, the enhanced measurement can be considered accurate to within ± 5% of reading if some care was taken to disregard single-value peaks caused by noise in the measured data. This was felt to be acceptable accuracy for the current AEN test program.

As observed in Figure F-6, short duration Halon pulses were enhanced much more than long duration pulses. This is also illustrated by plots of actual AEN test data acquired in the F-16 Nacelle Simulator using Halon 1301 in a 600 psig aircraft-type dump system (Figures F-10 and F-11). In the case of figure A-10, about 0.14 lbs of Halon 1301 was dumped into the nacelle with no ventilation airflow. The Halon pulse rose to its peak value about 400 ms after the Halonizer first began to respond to the presence of the agent. The enhancement increased the peak concentration level by 10% over the original measurement. In the case of Figure F-11, a similar (0.16 lb) Halon charge was dumped into a 2.5 pps ventilation airflow. The original curve reached its peak within about 170 ms. In this case, the enhanced data reached a peak concentration 36% higher than the original measurement.

An example of non-enhanced Halon concentration data for all six Beckman channels acquired during recent testing with the F-16 Nacelle Simulator in the AEN is shown in Figure F-12. The same data are shown enhanced using this enhancement technique in Figure F-13.

## F.2 DERIVATION OF TRANSFER FUNCTION

A gas analyzer Beckman model LB-2 was used to determine the Halon concentration of the inlet gas. The response time of the Halonizer (Beckman model LB-2) and sample tube filter was approximately 200 ms. This response time was faster than most Halon measuring instruments available on the market. However, for some tests with short durations, reducing the response time becomes necessary to properly monitor the concentration of input gas. To accomplish this task, a simulated system was used to accept the sampled output

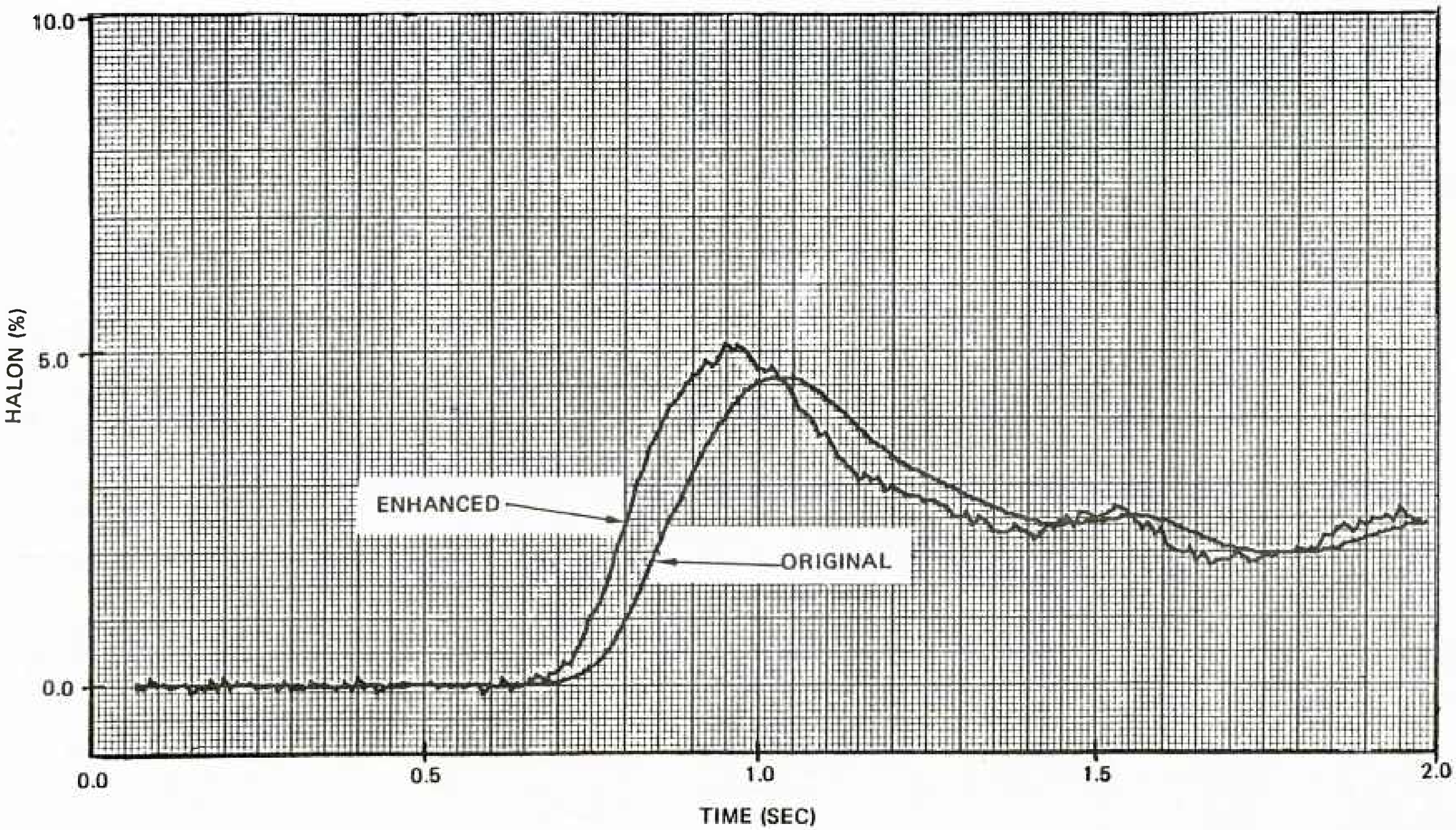



*Figure F-10. AEN Test Plot Illustrating Enhancement of a Slow Rising Halon Pulse*

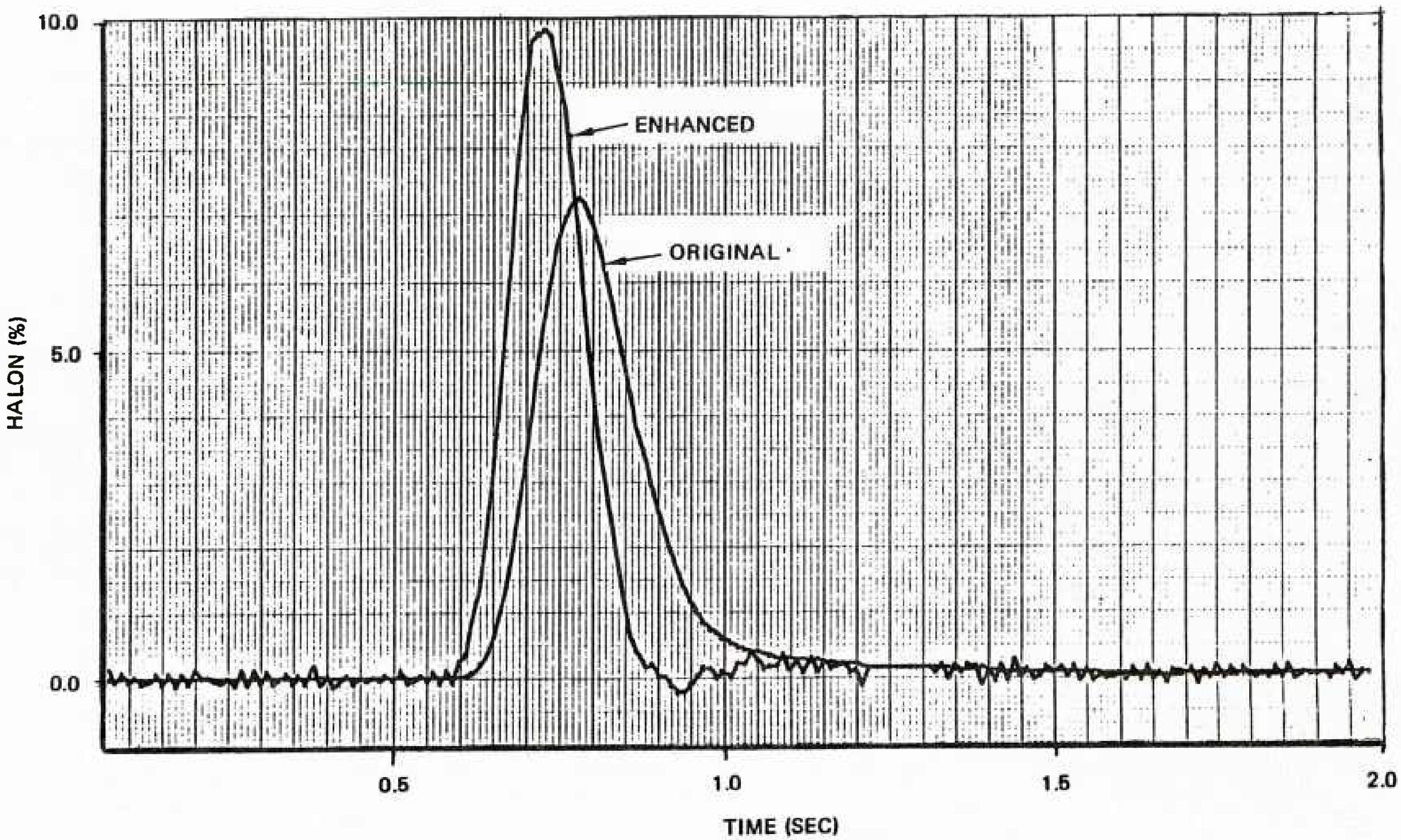



*Figure F-11. AEN Test Data Plot Illustrating Enhancement of Fast Rising Halon Pulse*

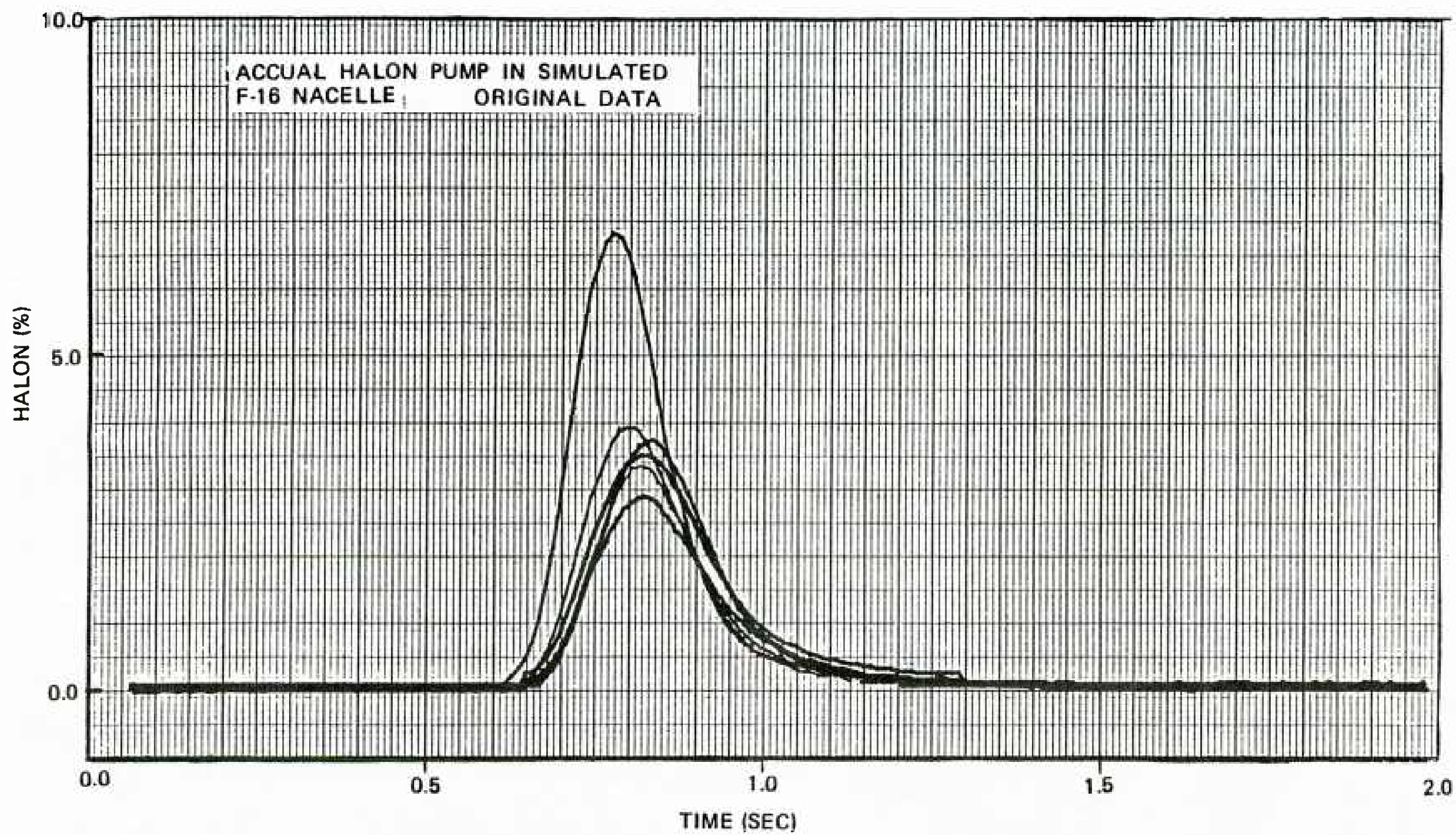



*Figure F-12. Normal Six-Channel Halon Concentration Data From AEN Testing Using the F-16 Nacelle Simulator*

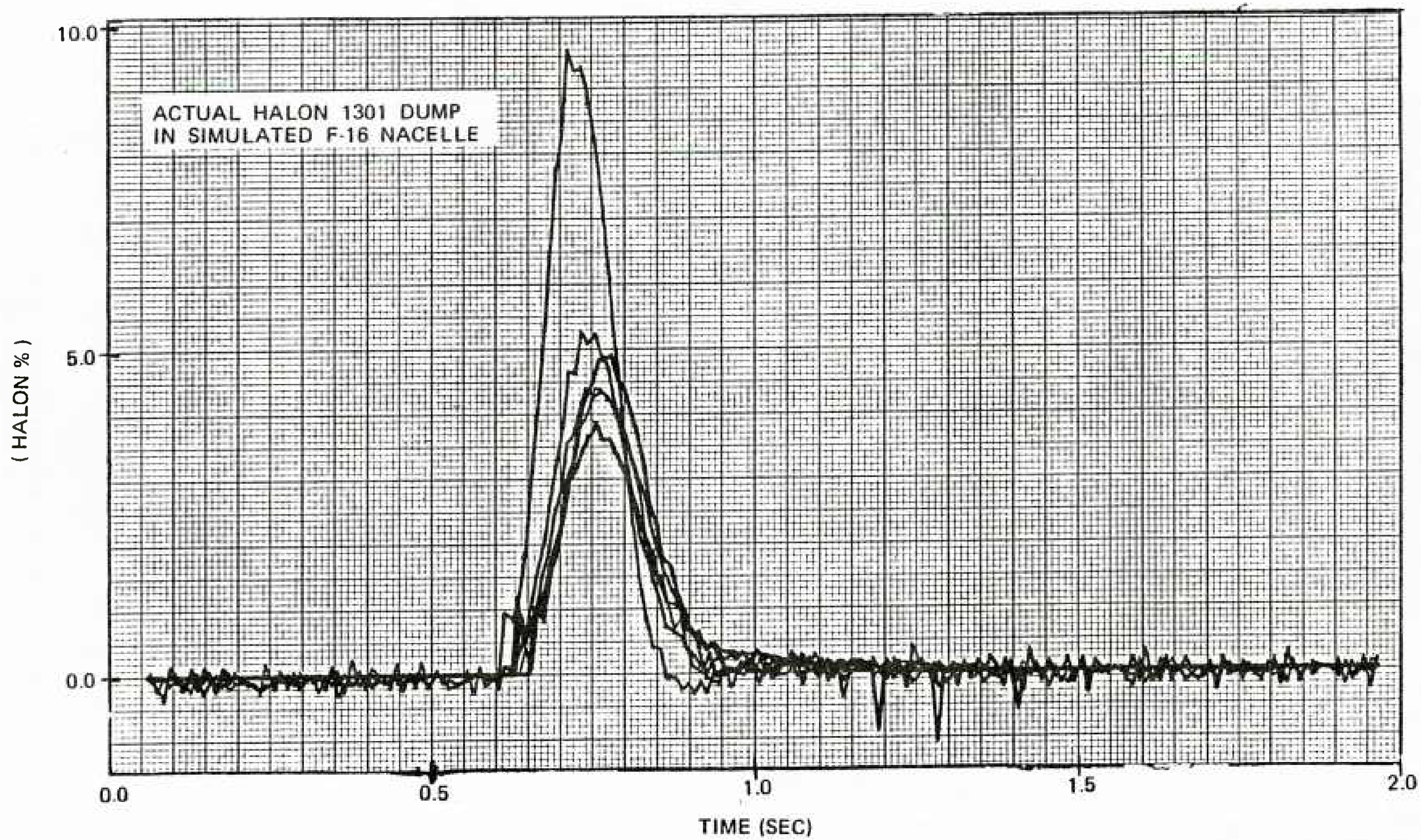



*Figure F-13. Example of Enhancement of Normal Six-Channel Beckman Halon Concentration Data* of the halonizer and to generate data more representative of the gas concentration input to the halonizer. The following describes the characteristics of such a system and briefly provides a background for this procedure.

A function f(t) is applied to the input of LB-2, and the output x(t) is sampled at 100 Hz and is fed to the input of a system having an impulse response of h(t). Then, x(t) can be expressed as:

$$x(t) = \sum_{k=0}^{k=m} a_k e^{s_k t} \qquad \text{for } t > 0$$

$$x(t) = 0 \qquad \text{for } t < 0$$

where $s_k$ are the poles of the transformed signal which will be either real or conjugate pairs in the complex domain. The impulse sampled of the output x(t) is the sampled sum of the individual component $x_k(t) = a_k e^{s_k t}$.

$$\text{Therefore, } x^*_k(t) = \sum_{n=0}^{\infty} a_k e^{s_k t} \delta(t-nT)$$

$$\text{and } x^*(t) = \sum_{k=0}^{k=m} \sum_{n=0}^{\infty} a_k \delta(t-nT) e^{s_k t}$$

The Laplace transformation of the input is:

$$x^*(s) = \sum_{k=0}^{m} [a_k(1 + e^{s_k T} e^{-sT} + e^{2s_k T} e^{-2sT} + \text{-----} + e^{ns_k T} e^{-nsT})]$$

$$x^*(s) = \sum_{k=0}^{m} \frac{a_k \left(1-e^{n(s_k-s)T}\right)}{1-e^{(s_k-s)T}}$$

Therefore, the output of this simulated system is:

$$y^*(t) = L^{-1}[H^*(s) \sum_{k=0}^{m} \frac{a_k}{1 - e^{(s_k-s)T}}]$$

where $H^*(s) = L\ [h^*(t)]$ is the system function of the simulated system, and $\left|e^{(s_k-s)T}\right| < 1$ for $k = 0, 1, \ldots, n$.

Now, if a unit step function is applied to the input of the LB-2, then the LB-2 output $x(t) = L^{-1}\left[\frac{k}{s(s+\frac{1}{T_1})(s+\frac{1}{T_2})(s+\frac{1}{T_3})}\right]$

This function, with a reasonable degree of accuracy, can be approximated with a single time constant function.

If a single time constant exponential is applied to the input of the simulated system and results in a step output, then:

$$x(nT) = 6.8(1 - e^{-nT/\alpha})\, u(nT)$$

and

$$y(nT) = 6.8u(nT)$$

and

$$y(nT) = \sum_{k=0}^{n} x(kT)\, h(nT - kT)$$

where h(nT) is the impulse response of the simulated system, $\alpha$ is the time constant and T is the sampling period.

Therefore, $6.8u(nT) = \sum_{k=0}^{n} 6.8\ [u(kT) - e^{-kT/\alpha} u(kT)]\ h(nT-kT).$

Applying the Z transform, results in:

$$L\ [6.8u(nT)] = L\ [6.8(1 - e^{-kT/\alpha})u(nT) * L\ [h(nT)]]$$

$$Y(z) = \frac{6.8z}{z-1} \quad \text{and} \quad X(z) = \frac{6.8z}{z-1} - \frac{z}{z - e^{-T/\alpha}}$$

$$H(z) = \frac{\frac{6.8z}{z-1}}{\frac{z(1 - e^{-T/\alpha})}{(z-1)(z - e^{-T/\alpha})}} = \frac{z - e^{-T/\alpha}}{1 - e^{-T/\alpha}}$$

$$Y(z) = \frac{z}{1-e^{-T/\alpha}}X(z) - \frac{e^{-T/\alpha}}{1-e^{-T/\alpha}}X(z)$$

where $\alpha$ = 68 ms and T = 10 ms then,

$$y(nT) = L^{-1}[Y(z)] = 7.3x[(n + 1)T] - 6.3x(nT)$$

Variable definitions:

| | |
|---|---|
| k | exponential component index |
| $a_k$ | exponential component weighting factor |
| $s_k$ | a pole of transformed signal |
| t | time |
| n | sample number |
| T | sampling period |
| $\delta$ | Dirac function |
| f | LB-2 input |
| x | LB-2 ouptut |
| h | simulated system impulse response |
| y | enhanced output |
| u | unit step function |
| z | variable in z domain |
| X | simulated system input, in z domain |
| Y | simulated system output, in z domain |
| H | system function of the simulated system, in z domain |
| $\alpha$ | time constant |
| s | variable in s domain |

## F.3 Software

The following shows the subroutine for the implementation of this transformation:

```
   SUBROUTINE
C***********************************************************
C  SUBROUTINE HPLPLT                                HIPO 4.2.3
C  VERSION 2.0                        DATE 20 JUL 83
C***********************************************************
C
  IMPLICIT DOUBLE PRECISION (D)
C
   DIMENSION XDATA(200,6),YDATA(200,6),ILABLX(3),ILABLY(3),
```

```
  1          ICOLOR(3)   ILINE1(20),  ILINE2(20),  YDATA1(200,6)
   COMMON/HPLCOM TIMEON , TIMOF , IPROBE , IDUFT , ICOND , IRUN,
  1               DPARMN(9) , RPARMT(6) , RPARMV(200,6) , NPNTS ,
  2               ICNDNM , IRUNNM , RSCNDS(200)
C
   EQUIVALENCE (ILABLX, DLABLX) , (ILABLY,DLABLY) (IHALON,DHALON),
C
C
C  GET TITLE
   WRITE (42,100)
   WRITE (42,101)
   READ (41,102) ILINE1
   WRITE (42,103)
   READ (41,102) ILINE2
C
C
C  MOVE DATA INTO THE X-AXIS ARRAY
   RSECS = 0.07
   NPNTS = NPNTS - 1
   DO 10 I = 1, NPNTS
      DO 20 K = 1, 6
      XDATA (I,K) = RSECS
20    CONTINUE
      RSECS = RSECS + 0.01
10 CONTINUE
C
C
C  SET X AXOS MA,E
   DLABLX = DPARMN(3)
   DLABLY = '%HALON'
C
C

C    MOVE DATA INTO THE Y-AXIS ARRAY
     DO 30  I = 1  , NPNTS
        DO 40 J =  1, 6                                               array
        YDATA(I,J) = RPARMV (I,J)                                  trans-
        YDATA1 (I,J) = 7.3*RPARMV (I+1,J) - 6.3*RPARMV(I,J)       forma-
40    CONTINUE                                                      tion
30    CONTINUE
     CALL HMNMX(NPNTS,XDATA,YDATA,XMIN,XMAX,YMIN,YMAX,IERR)
C
C
C  PLOT WHATEVER
80 CALL SKALE(0.,2.,6.,KX,ADJX,DELTX)
   CALL SKALE(YMIN,YMAX 4.,KY, ADJY, DELTY)

   CALL INITT(1200)
   CALL HLABL (200.750,ILINE1,40)
   CALL HLABL (200 725,ILINE2,40)
   CALL XAXIS (0.6,0.4,ILABLX,6,6.,ADJX,DELTX)
   CALL YAXIS (0.6,0.4,ILABLY,6,4.,ADJY,DELTY)
   IYVAL = 750
   NPNT = NPNTS - 1
```

```
C
C
C
60 WRITE (42,110)
   READ (41,111) IANS
   IF ((IANS NE.'Y').AND.(IANS.NE.'N'))  GOTO 60
   DO 50 I = 1 , 6
      IF (I.GT.1)  WRITE (42,140)
      WRITE(42,150) (DPARMN(I+3))
      READ (41,121) (COLOR(J),J=1,3)
      DHALON = DPARMN(I+3)
      CALL HLABL (700, IYVAL, IHALON,6)
      CALL HLABL(800,IYVAL,ICOLOR,6)
      IF (IANS.EQ.'N')
   1  CALL HLINE(XDATA,ADJX,DELTX,YDATA,ADJY, DELTY,NPNTS,I,2,0)
      IF (IANS.EQ.'Y')
   1  CALL HLINE(XDATA,ADJX,DELTX,YDATA1,ADJY,DELTY,NPNT,I,2,0)
      IYVAL = IYVAL - 25
50 CONTINUE
   CALL FINITT (0,780)
70 WRITE (42,130)
   READ (41,111)  IANS


   IF ((IANS.NE.'Y').AND.(IANS.NE.'N'))  GOTO 70
   IF (IANS.EQ.'Y')  GOTO 80

C
C
C  FORMATS;
100    FORMAT (1X, 'ENTER TEST TITLE UP TO 2 LINES LONG: ')
101    FORMAT (1X, 'ENTER LINE 1 UP TO 40 CHARACTERS <CR>: ')
102    FORMAT (20A2)
103    FORMAT (1X, 'ENTER LINE 2 UP TO 40 CHARACTERS <CR>: ')
110    FORMAT (1X, 'ENTER TO PLOT ENHANCED DATA AS Y <CR> OR N <CR> ?')
111    FORMAT (1A1)
130    FORMAT (1X, 'ENTER TO PLOT SAME DATA AS Y <CR> OR  N <CR> ? ')
140    FORMAT (1X, 'CHANGE PEN COLOR ON FLATBED PLOTTER ')
150    FORMAT (1X, 'INPUT COLOR' 1A6.' AS AAAAAA <CR>  ? ')
121    FORMAT (342)
C
C
C  EXIT
   RETURN
   END
```

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